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A TECHNICAL AND COMMERCIAL PERIODICAL
DEVOTED ENTIRELY TO THE SUGAR INDUSTRY

EDITED BY:
NORMAN RODGER AND JAMES P. OGILVIE, F.I.C., F.C.S.

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Notes and Comments.

The War.

During the past month the consequences of Mussolini's ill-starred attack on Greece have become increasingly evident to the weaker partner of the Axis. Aided by British naval and air forces, the Greek armies have had an uninterrupted run of success in driving the Italian forces back to the western plains of Albania; the coastal ports through which the Italians counted on reinforcing their Albanian army have been under continuous attack both from the air and from the sea, and most of them have been rendered more or less *hors de combat* The remnants of the Italian fleet smashed at Taranto, on seeking a safer harbour in the Tyrrhenian Sea, only escaped after another running fight in which further damage was done to their units by a British naval force.

But the greatest development has been on the African littoral, where the long-delayed plans of the British army in Egypt to attack the Italian force in Libya came to fruition last month. It seems clear that this recent attack was intended in any case and was actually delayed by the necessity to divert some of our air force to go to the assistance of Greece. But the latter's decision to fight the Italians and the early successes achieved in Albania must have proved of great stimulation to the British command in Egypt, in that it gave them a more exact measure of the moral strength of the Italian fighting forces. So when the British struck on the borders of Egypt and Libya with a clever enveloping movement carried out by mechanized units, they had no difficulty in sweeping the Italians out of their advance base at Sidi Barrani, some 60 miles inside Egypt, and cutting them off further west at the border town of Sollum. The tactics employed by our forces were similar to those adopted by the German mechanized units in overrunning Belgium and France. A large number of rapidly moving tanks and armoured vehicles and a comparatively small personnel were able to take the Italians by surprise and round up as prisoners some 35,000 to 40,000 of the enemy, as well as very large amounts of equipment and stores collected at the advance Italian base for an eventual attack on Egypt What rendered the feat easier of performance was that, as the fighting was necessarily confined to a coastal strip, the Navy was able to lend a hand and bombard the Italian positions from the sea, while the R.A.F. maintained an ascendancy over the Italian air forces to a degree which surpassed expectations.

The result is that a serious threat to Egypt is wiped out in a few days' fighting, and the Italians in Libya are desperately defending some of their coastal towns and strong points from attacks by fresh British forces coming in from Egypt. The Italian commander professes to have been anticipated by the British attack just when he was about to initiate an attack of his own on Egypt; but the world will wonder for the time being why his seizure of Sidi Barrani some three months previously was not followed up by such an operation just when the British in Egypt were suffering from the blow of the defection of the French colonial forces and were not themselves in any position to attempt any fighting. We now know that when the *Blitzkrieg* started in England last August, the British forces in Egypt were dangerously small for the dangers that threatened them, and it speaks well for the Government at home that they decided to send out large reinforcements just at the moment when the threatened invasion of Britain loomed largest. As Mr. Churchill put it, we had to take risks if we were to succeed, and fortunately the risks were successfully surmounted, and we have been able to deal another staggering blow to Italian aspirations in the Mediterranean.

This success in Libya, combined with the Greek defeat of the Italians in Albania, provides such a severe reverse for Italian arms that it may well be doubted whether Italy, if left to herself, could stage any recovery. She is fighting a war on three fronts, all separated from the home country by a sea which she no longer even pretends to command, and her main enemy now holds naval and aerial bases on Greek territory which make it a simpler task to

cut all Italian sea communications. If she calls on her German partner for aid, she will probably only get it at a price, the loss of her independence and her incorporation in the German hegemony, which is probably more than the Duce cares to face. Germany professes to be indifferent to what is happening in the Mediterranean. In any case a winter campaign in the Balkans is hardly part of her plans there, but she may be forced to make some premature move if her Axis partner's position becomes desperate. On the other hand, all the indications are that Germany considers her main task now is the attack on England. Her U-boat campaign is being ruthlessly pursued and for the time being is getting results, as the British Navy (which in the last war had five naval allies at one time or another) has a multiplicity of tasks on its hands other than convoy work and evidently needs more time to develop its ultimate strength. The German preparations for an attack on this country have only been scotched by the Autumn campaign and are almost certain to be re-attempted with possibly greater force and desperation, and at any moment between now and the Spring. Against the consideration that the Spring weather might be more propitious for the task, there exists the necessity to attack, if possible, before British equipment receives the additional supplies which the coming months promise, both from home workshops and from overseas. So Britain stands on guard, prepared to receive the onslaught, whether it comes tomorrow or two months hence, and in the belief that however desperate the attempt, the result will be a defeat for the Germans such as will stiffen the secret resolves of all the subject peoples and harden the hearts of those few countries in Europe who have not yet given in to German domination.

The increasing support accorded this country by the United States has yet to be fully assessed, and further offers of help, both material and financial, seem on the tapis. German opinion, which earlier scoffed at their effectiveness, as due to come to hand too late for the purpose, is now undeniably alarmed at the prospect of the growing assistance from across the Atlantic; and this fear may prove a factor in accelerating German plans of campaign to a point where they may run the risk of being insufficiently prepared. In other words, the Germans may have to stake all on a giant gamble, and not on a fully planned and executed effort.

British Sugar Machinery Trade.

Just a year ago we drew attention to the fact that the sugar machinery trade of the United Kingdom had not suffered, owing to the outbreak of war, any such setback as some of its overseas competitors were inclined to visualize. This was largely due to the fact that the British Government early in the struggle realized the importance of obtaining foreign exchange with which to purchase war material abroad, so the export trade was encouraged and all facilities possible were granted the manufacturers concerned to enable them to continue accepting orders from overseas. The sugar machinery industry in the United Kingdom is essentially an export industry, as all the cane sugar machinery made by it goes abroad; the amount of beet sugar machinery required by the home industry is at present relatively small.

After another twelve months of warfare, latterly greatly intensified, one is glad to be able to report that the position of British sugar machinery trade is, in the circumstances, well maintained, and reports that its activities have been seriously curtailed are hardly borne out by the record of achievement during the past year. It should not be overlooked that in times like the present, when the ramifications of the struggle in Europe reach all over the world, even such stable concerns as sugar factories are not likely to embark on radical improvements without urgent reason, and ordinarily will content themselves for the time being with such necessary additions and normal replacements as are incidental to their continued economic well-being. So the business offering in wartime could hardly come up to that which might be expected to accrue in more peaceable days. But allowing for some inevitable slowing down of world-wide orders in those circumstances, the United Kingdom sugar machinery manufacturers can be said to have secured a reasonable share of the business offering of late months. Certainly the scope of their markets does not appear to have been materially affected by wartime conditions, as it is noticeable that, in addition to Empire markets in the Dominions, India and the sugar-producing Colonies, reports indicate that shipments have been made to the customary markets in North and South America, Africa, Asia, and to the only cane sugar producing country in Europe—Spain.

These British firms, of course, have had to play a part in the highly organized rearmament programme in Great Britain, but the Government, with an eye to the value of the export trade, has given them time and facilities to keep up their usual overseas business as well as to invade markets served by enemy or enemy-controlled territory, and as a consequence they have been able to execute many important overseas contracts since the beginning of the war, and the machinery has been transported to the factory sites in all parts of the sugar-producing world with comparatively little loss by enemy action and with a measure of punctuality which in most cases has been affected more by the much less regular sailings of the shipping concerned than by any inability of the manufacturers to complete to time. There may have been delays in some particular cases; but when one considers the problems of demand for materials and skilled labour, to say nothing of the

new conditions of "black-out" in workshops which have been met and surmounted, these delays have been understandable.

To assist the British export trade generally, a system of Export Groups was early instituted by the Government. These Groups are not trade associations; their particular function is to assist their industry by collecting information regarding its requirements, so as to ensure that the necessary materials will be available with as little delay as possible as and when required. Amongst the earliest of these groups to be formed was that of the Sugar Machinery Manufacturers, a ready consequence of the fact that all the engineering firms in Britain having an interest in sugar machinery were already members of the "British Empire Sugar Machinery Manufacturers Association" formed in 1916; for this group a firm of chartered accountants in Glasgow act as secretaries and form the point of contact with the various Controls, assembling data required and supervising distribution of raw materials within the Group, so that trading information and the data of individual members are not disclosed to others of the Group. We gather that this body has been very fairly treated by the Ministry of Supply, who have encouraged the export of sugar machinery and seen that adequate raw materials were available for the machinery makers. Hence a considerable quantity of sugar machinery has been built during the past year.

Recent British Exports.

Amongst the more important orders we may cite the completion and shipment by one Glasgow firm of an entire sugar factory for India; two other Glasgow firms are well forward with the building and shipment of machinery for an interesting modification to one of the larger Indian factories, whereby the capacity will be doubled; the extension, by an English firm, of a 1500-ton factory in South America, including new buildings for Mill and Boiling Houses (the latter being reorganized, with the addition of two 10 ft. pans); the supplying by this same firm of plant to complete a factory which had been ordered from Germany and for which only a part of the necessary machinery had been delivered on the outbreak of war. The machinery requisitioned from the various firms has, in fact, ranged over every station in the factory; orders for mill rolls have been particularly numerous, and in view of the excellent quality of the special roll metals supplied by British sugar machinery manufacturers, the ready availability of this replacement item must have proved of no small value in maintaining contacts with customers.

The tendency towards efficiency in the cane sugar industry is particularly apparent to firms who have undertaken the manufacture of specialities and patented articles; for instance, the firms manufacturing centrifugals report various orders for batteries of the latest types of high-speed machines, and other developments in centrifugal design include the further application of the hydraulic coupling to the drive. Another firm has orders for eleven continuous clarifiers of the most recent design. All are agreed that the demand for spares and repairs is unusually high, whilst the demand for new units to increase capacity and efficiency is well in line with that of recent years.

It should be added that, so far as the purchaser is concerned, one important result of the control of British industry, which includes the control of the cost of raw materials, is that British sugar machinery manufacturers are able to quote not only fairly reasonable deliveries but very competitive prices. A system of emergency co-operation is in force to ensure that in the case of enemy action other workshops can take over the completion of a job and so obviate delays. Moreover, machinery under construction is insured under a Government scheme, so that if the worst should happen the customer will suffer no financial loss.

Customers are, however, advised to place their orders as early as possible, but this recommendation need not be read to mean that they need be apprehensive with regard to delivery. While it has to be assumed that transport will not be as rapid as in normal times, the main consideration is the fact that the British engineering industry is now highly organized, and as sugar machinery orders are apt to be large and irregular, the longer the time the customer can give the manufacturer, the easier will it be for the latter to plan his programme so as to give the customer the best service.

Conditions in Trinidad.

At the annual meeting of the St. Madeleine Sugar Company Ltd. held at the end of November, the Chairman (Mr. J. M. du Buisson) said that their very short Trinidad sugar crop, chiefly due to adverse weather conditions during the planting season, and also to froghopper attack, came at an unfortunate time for the Company, in view of the fact that the United Kingdom wished during 1940 to get as much sugar as possible from the Dominions and Colonies. Actually the cane supply showed a drop of 26 per cent. as compared with the previous year, evenly divided between estates and farmers. In consequence, production costs increased considerably, both from the poor cane return and by the higher cost of materials and wages. The result was a profit of only £14,576, an amount more than swallowed up by appropriations for taxation.

The Report of the Royal Commission's visit to the West Indies has not been published as yet, but a great many of the recommendations are known to concern welfare and social services, and deal, in fact,

with the best method of improving existing services. But there is little doubt that sugar producers in Trinidad are barely making both ends meet, and it is obvious, therefore, that the industry has nothing in hand for such improvements, unless it gets a higher price for its sugar. The alternative is further contributions from the Home Government.

During the past year the St. Madeleine Company have not been able to make any progress with housing, nor has Labour made much progress towards an understanding of the functions of Trade Unions. Their factory labour, which now works during the crop on a three-shift system of 8 hours each, has been entirely satisfactory, but on some estates field labour has been rather unsettled, with a consequent prolongation of the crop season. The question of speedier delivery of the cane to the factory has still to be solved; several mechanical methods have been tried, but so far all have proved a failure owing to the difficulty of crossing the large drains in the fields. Further experiments will be made during the coming crop with more success, it is hoped. The acreage under Uba is being gradually reduced, to the benefit of both the railway and the factory.

As for the future, the St. Madeleine exportable crop has again been sold to the Government at 27s. 6d. per ton more than the previous crop; but it is reckoned that this increase will be absorbed by higher costs of production. Crop prospects for 1941 are at present none too bright, as the island has had quite a severe attack of froghopper recently and the weather on the whole has been too dry. Consequently, the coming St. Madeleine crop is not expected to exceed 40,000 tons of sugar, as compared with 34,044 tons in 1940. The best out-turn in recent years was in 1936, when 54,236 tons was obtained.

Tate & Lyle.

The accounts of Tate & Lyle Ltd. for the year ending September last are necessarily much less informative than in normal times. The actual financial period covered is 55 weeks, as compared with the 49 weeks of the previous report. The Directors state that it was not possible in time to assess the liability to taxation in respect of the profits under review, and a reserve has had to be made to meet the whole of the 1940-41 liability to income tax and a substantial provision in advance for the 1941-42 liability. The published profits afford little indication of the change in the trading figures since the balance is struck after tax allowance; the trading balance is given as £973,122 as compared with £1,148,179 in 1938-39, and the net profits of £1,032,418 compare with the previous year's £1,319,788. Nothing is put to general reserve this year, as against £300,000 a year previously. The profits were sufficient to maintain the Ordinary dividend at 13½ per cent., and £71,496 was carried forward.

War-time limitations precluded Sir LEONARD LYLE, Bt., M.P., the President, from giving his usual survey of the sugar industry at the annual meeting of the Company held last month. He had to content himself with recording an appreciation of the manner in which the Sugar Division of the Ministry of Food has worked in close co-operation with the Company and the other sugar refiners throughout, with the result that the sugar supplies of the United Kingdom have been maintained in spite of all difficulties and the consumer has never failed to receive his ration.

Some West Indian Pests of the Sugar Cane.

The small moth-borer, *Diatraea saccharalis*, is well known as a pest prevalent in all the commercial cane growing areas of the New World; here it is, in fact, the major pest, and a very large expenditure of energy has been incurred in its study with a view to ultimate control. A review of the present position, with especial reference to Barbados, is the subject of an article by R. E. W. TUCKER.[1]

A brief review of the main facts concerning this pest shows that it is recorded from practically all the cane areas of the New World with the exception of the Bahamas and Tobago. It is one of some 50 species of *Diatraea* of which, however, two only, *D. canella* and *D. impersonatella*, are also serious pests of the sugar cane. The former is limited to the Guianas and Venezuela on the mainland, and to the West Indian Islands from Trinidad in the South to St. Lucia in the North; the latter is of importance only in Trinidad but is a minor pest in South American cane fields. Neither occurs in Barbados. In addition to cane, *D. saccharalis* attacks maize, sorghum, rice, and a number of wild grasses. The account refers only to this species.

With its wide distribution, the pest is naturally exposed to a very varied range of climatic conditions to which it has adapted itself. This range extends from sub-tropical areas with frosts in season when hibernation takes place, to tropical conditions with relatively small temperature variations and with continuous and overlapping cropping seasons when resting periods are the response to drought and not hibernation. Barbados, as a small tropical island with no great altitudes, has a singularly equable climate. Temperatures range from around 63°F. minimum to around 88 to 89°F. maximum. These are records in the open; in the cane fields themselves the minimum temperatures are almost always 2 to 3°F. lower and maximum temperatures 7 to

[1] *Tropical Agric.*, 1940, 17, p. 133.

11°F. higher than these. Similarly, humidity within the fields differs frequently from external humidity and ranges from 30 to over 100 per cent. Of other factors which are likely to influence the intensity of the pest, two would appear to be of especial importance. Barbados is so closely cultivated an island that, though there are a number of alternate food plants (which are listed), their occurrence is sporadic and they are reaped at frequent intervals for fodder and bedding and so form very ineffective reservoirs for the insect. On soil too thin for cultivation of crops, sour grass (*Andropogon pertusus*) is planted and this plant is not a host for the pest. On the cultural side, the reaping season coincides with a dry, windy period. These conditions, however, react in two directions; while not severe enough to eliminate the pest, they seriously interfere with the various natural parasites and predators. In fact, of these, *Trichogramma minutum* alone appears to be able to overcome these natural handicaps.

The habits of the pest are described. These are sufficiently well known to need no repetition. Emphasis is, however, laid on the larval diapause which takes place during any prolonged break during the rainy season. The main result of this is an increased intensity of attack due on the one hand to the slower recovery of the cane plant from the effects of drought and, on the other, to a greater injury to the parasite.

Parasitism is dealt with in some detail. Of the hymenopterous insects one, *Trichogramma*, alone is in any degree effective, and of it several biological races are known. The only other parasite found in Barbados is *Microdus stigmaterus*, but only seven cases were found in over 38,000 larvae. Introduced hymenopterous larval parasites failed to establish themselves. Dipterous parasites are numerous, but the outstanding examples are *Lixophaga diatraeae*, *Metagonistylum minense* and species of *Paratheresia*. These, with their various species and strains, are adapted to very different ecological conditions, and for successful introduction it is important to select that one which is best adapted to the local conditions of the new home. The first, as well as *P. claripalpis* and *P. diatraeae*, the two species of this genus which appeared to be best adapted to Barbadian conditions, have been introduced into Barbados but so far without success. Attempts with *M. minense* have so far failed, but there are two distinct strains, adapted to very different ecological conditions, and others may exist. The possibilities of this parasite have not been fully tested. The fungal parasite, *Cordyceps barberi*, can, on occasion, exercise a marked degree of control, but is too dependent on the seasonal conditions to be reliable.

Among predators are mentioned the ant *Monomorium carbonarium ebenium* of Puerto Rico, and, in Barbados, the Acarid *Belaustium sp.*, the larva of the lacewing *Chyrsopa sp.* and an unidentified black ant. All these, unfortunately have not the capacity to distinguish between parasitized and unparasitized eggs. These are all egg predators. Larval and adult predators are not of any importance.

Control of the pest is in some measure obtained by cultural practices such as density and times of planting, frequency of ratooning, burning of fields of standing cane or of trash and choice of varieties. But beyond these, control has been attempted through encouragement of the parasites. This takes the form either of introduction of parasites hitherto unknown in the particular country, in the hopes that they will find a congenial environment free from the hyper-parasites to which they themselves succumb in the former home, or of the artificial increase of native parasites. In Barbados, difficulties in the way of finding a parasite adapted to the environmental conditions of that island have led to the greatest concentration of effort on the multiplication of the native *Trichogramma*. Local experience in this effort would seem to indicate that the maximum effectiveness of this parasite as a control is only secured between narrow limits of temperature and humidity approx. 90°F. and 100 per cent. humidity, though the survival capacity covers a very wide range of conditions.

If the moth-borer is a pest found widely scattered throughout the cane fields of the western hemisphere including the West Indies, there is another serious pest the distribution of which, at least as a menace, is much more restricted. This pest is the frog-hopper which, on occasion, is capable of doing extensive injury in Trinidad. Here it has been recognized as such for over 60 years and all the varied means of control have been tried with only partial success. A further contribution to the subject of control is to be found in an address by A. Pickles.[1] The most successful of these earlier attempts was probably cyanogas, though the expense was considerable, and the work laborious and insufficiently rapid in the case of a severe outbreak.

The method here described involves the use of that well-known insecticide *Pyrethrum*. Success lies in the development of a tractor-operated dusting machine of sufficient power to blow clouds of the powder over the field; the dust must, in fact, be discharged at a speed of 180 miles per hour. Further, it is desirable to select the evening for the work. The actual machine used enabled some 12 acres to be treated per hour. An economy was found by the dilution of the pyrethrum powder with an equal weight of sulphur and, with this, the cost averaged $1·42 per acre. The success attained is illustrated by diagrams of treated fields. These show that mortality was, as a rule, between 80 and 99 per cent. Further, treatment of the second brood resulted in only a mild attack from the third brood which happened to be unusually severe.

H. M. L.

1 *Proc. Agric. Soc. Trinidad and Tobago*, 1940, **40**, p. 57.

Soil Investigations in Cuba.

Proceedings of the 13th Annual Conference of the Asociacion de Tecnicos Azucareros de Cuba, 1939.

Among the papers read at the 1939 Conference of **Cuban Sugar** Technologists, one by B. R. ARGUELLES **constitutes** a plea for a clearer recognition of the **objectives** which the various analyses commonly **undertaken** have in view. The various features of the several determinations forming the stock-in-trade of the analyst are very briefly discussed from this aspect.

The survey of Cuban soils by BENNET and ALLISON in 1927 was, with a supplementary survey, responsible for the identification of 128 soil types. The basis of the classification is colour—black, brown and red; but within these three groups sharp differences are found in suitability for the culture of cane. In a paper entitled The Influence of Colour on Soil Productiveness, C. E. BEAUCHAMP sets himself to answer the question, does any difference exist in the productive capacity of these soil groups based on their colour ? The answer is given by an analysis of the replies received to a questionnaire, circulated to all centrals by the Department of Agriculture, from which the percentage of black, brown and red soils, as well as the average yield of fall cane, was obtained for most of the plantations. Official reports were also enlisted to supply figures of yields of cane and sugar for the two years 1937 and 1938, together with the average yields of these for the 5-year period to 1938.

The data thus accumulated were first grouped into 21 groups according to the percentage area occupied by the three colour types of soil, the unit being in each case taken as 20 per cent. Thus, 11, 8 and 5 were the number of plantations cultivating soils which were respectively entirely (100 per cent.) black, brown or red. Intermediate stages are represented by the group, composed of 11 plantations, having 40 per cent. of the soils black, and the remainder (60 per cent.) brown; and by the group of eight plantations having 40 per cent. of the soils black, 40 per cent. brown, and the remaining 20 per cent. red. A series of diagrams were then prepared in which the three angles represent the 100 per cent. unit of the three colours and the respective bases the zero percentage, the four intermediate (20 per cent. difference) points marking the intermediate positions in the manner of the Schreiner triangle. Into such triangles the sum of the yield figures for cane and sugar is inserted at the appropriate intersections, and arrows indicate the incremental direction between all neighbouring points of intersection. From these directional arrows indices are obtained for each type of soil colour, the respective index being the number of arrows pointing towards the angle representing 100 per cent. of that colour.

The first graph illustrates the position with regard to yield of plant fall cane in 1938, and the respective indices are : black 23, brown 14, and red 8. Interpreted in terms of soil condition, this is taken to indicate that the black soils, being the younger, are less friable and porous than brown, and these, again, than red. In the above order they exert a retarding effect on seepage and hence on the leaching of soluble minerals. Later graphs illustrate the cane yield (all cane) for 1938, 1937 and the five-year average ending 1938. In the first of these, the indices are black 14, brown 21, and red 10; in the second, black 18, brown 14, and red 13. The five-year average, however, shows a very different position. The indices here are black 13, brown 14, and red 18. Interpreted in terms of the crop, these figures indicate that black soils, though producing a high tonnage as plant canes, undergo some change which renders them less favourable for ratoon crops. Two possibilities are suggested for this behaviour of the black soils; either, though the supply of plant nutrients in them may be adequate, their physical conditions are unfavourable for root development or the rate of restoring the available nutrient supply is inadequate for the later growths. The brown soils appear to be better with more stable physical conditions, while the red soils, though physically excellent for sugar cane, have a lower potential fertility due to the readiness with which leaching takes place in spite of a high rate of restoration of the available nutrients. That the physical condition is the more important factor is suggested by the fact that black soils, generally speaking, do not respond to fertilizers while red soils do.

When attention is directed to the yield of sugar (96°) a different result is obtained. For the 1938 crop the indices are, black 14, brown 11, and red 20; for the 1937 crop they are, black 15, brown 9 and red 21; whilst for the five-year average they are black 12, brown 12, and red 21. It would appear from these figures that the lowest cane producing soils yield the highest return of sugar and *vice versa*. The explanation of this is traced to the phenomenon of maturity; cane on the poorer soils has a relatively limited growth and matures earlier and, when age is used as the determinant for cutting, yields the heavier return of sugar. The practical problem of the red soils is to determine how, by the use of

irrigation, fertilizers and so on, to increase the cane yield without reducing the high sugar yield.

The conclusions here arrived at are, it is pointed out, in contradiction to earlier findings of the writer and others, that any treatment favouring a higher cane yield will result in a higher sugar content. As he points out, the contradiction lies in failure to consider the effect of maturity.

In the present study consideration is given to a single factor, the colour of the soil. This is not the only character and, as BENNETT and ALLISON had shown, within these major groups a large variety of soil types exist. The same method of analysis applied to these subsidiary types may well lead to information which would disclose means for increasing field yields and sugar output.

The same author (C. E. BEAUCHAMP) contributes a further paper entitled The Composition of the Alcoholic Extract of Sugar Cane Leaves as a Means of determining the Fertility of the Soil for this Crop. In recent years many endeavours have been made to use the plant as its own analyst. That, in fact, is the idea underlying field experiments. Here, however, the idea is different. The plant itself performs the initial stages of the analysis through its selective absorption of the essential nutrients, and the analyst in the laboratory performs the later stages in determining the amount of the different nutrients absorbed under the varying conditions of supply. This method of analysis may be said to be still in the experimental stage, the difficulty lying in the selective distribution of the absorbed nutrients in the vegetative tissues of the plant. It remains to be determined what tissues should be used in the determinations; these may be different in different plants, for the sugar cane is not the only crop which has been used for the purpose. In the sugar cane particular attention has been devoted to the leaf. The present author with his associates has earlier used the chlorophyll content of the leaf[1]; H. LAGATU and L. MAUME, in a series of papers in French journals, used the entire leaf; W. THOMAS used the entire foliage.[2] Wheat, potato and tobacco were used in the course of these experiments. The selective distribution, not only in the tissues but in accordance with age, has been pointed out in Mauritius in the case of the sugar cane.[3] The general conclusions drawn by these authors are that positive correlations exist between the mineral composition of the entire leaves of crop plants and their yields, and that the final yield is positively correlated with the total quantity of the mineral elements present in the leaves and with the proportion in which they are found.

In the present paper the alcoholic extract of the cane leaves is studied, but the concepts of THOMAS, LAGATU and MAUME are adopted, though in their case the basis is the entire leaf. These concepts embrace the "intensity of nutrition," this being the sum of the percentages of N, P_2O_5 and K_2O, and, for the proportion of these three nutrients, "the N-P-K unit," representing the ratio of each one of the three to the sum total expressed in milligram equivalents × 100. Having three variables, diagrammatic representation is possible by the triangular method used in the preceding paper. The fertilizer treatments compared are combinations of : N, 4 and 8 ; P_2O_5, 4, 8 and 12 ; and K_2O, 0, 4, 8 and 12.

The yields, both of crop and sugar, resulting from these various treatments together with the detailed analyses for N, P_2O_5.K_2 O, Ca and Mg content, as well as the intensity of nutrition figure, the sum of the first three of these, are set out in detail. The first conclusion is that the figure for the intensity of nutrition bears an intimate relation to yield whether in terms of crop or sugar content and where no increase in the intensity of nutrition occurred, the yield of crop and sugar content remains stable. Further, the relative proportions of the three fertilizer elements, expressed in terms of the N-P-K unit, exerted a material influence on yield whether of crop or sugar. Increments of potash resulted in a gradual increase in the intensity of nutrition with correspondingly high yields, such increments producing a corresponding reduction in the nitrogen content.

The effect of increments of nitrogen in the fertilizer was less uniform. Such increments, when the potash content was low, increased the intensity of nutrition and, at the same time, increased the potash content of the N-P-K unit; but when the potash content was high, such increments of nitrogen reduced the intensity of nutrition and decreased the potash content of the N-P-K unit. This effect was traced into the figures for sugar content, for an increase in the intensity of nutrition due to a nitrogen increment in the fertilizer did not affect the sugar content adversely whilst a decrease of the intensity of nutrition for the same reason led to a decrease of the available sugar content.

In these experiments potash appears to be the most important nutrient; definite information with regard to phosphorus was not forthcoming, as it would appear that the soils involved were adequately supplied with this element. Since these determinations were made on cane in its early stages of growth, it is suggested that such analyses would give positive information on the deficiencies and fertilizer requirements of different soils taking into account the need not only for increasing the intensity of nutrition but for equilibrating the N-P-K unit. Further applications lie in the determination of the differential requirements of varieties and in the ascertainment of the effect on yield of any factors which may positively or negatively affect the growth of cane in the field.

H.M.L.

[1] *I.S.J.*, 1937 p. 440. [2] *Plant Physiology*, 1937, p. 571 ; 1938, p. 677 ; 1939, p. 699. [3] *I.S.J.*, 1940, p. 200.

Clarification Experiments :

Effect of Mechanical Treatment on Floc Characteristics.

By J. G. DAVIES[1] and R. D. E. YEARWOOD[2]
Imperial College of Tropical Agriculture, Trinidad.

Little work has yet been published describing the effect of mechanical treatment on the characteristics of the flocs which result from the addition of lime and heat to raw cane juice. A notable example of this effect was observed during the earlier clarification work of our Department of Sugar Technology.

When mechanical or even vigorous manual stirring is used during the secondary stage of liming in the F.L. & D.H. process, the subsequent subsidation is poor and indefinite.

Even if a prolonged settling period is allowed, the decanted clarified juice may still be turbid and unsatisfactory. The result is due to the flocs formed earlier in the process being subjected to mechanical wear and tear. When the hot juice which contains in suspension what might be termed the primary floc is vigorously mixed with the secondary lime dose, the flocs are unable to withstand the violent action. Small fragments are broken off and the whole character of the precipitate is irreparably altered.

These preliminary observations indicate that once flocs are formed, the subsequent mechanical treatment should be of limited violence. The same principle is applied in factories where reciprocating pumps are installed in preference to the simpler centrifugal type for pumping muds to the filter. This has been accepted practice now for 10 years or so. But little attention appears to have been paid to the mechanical treatment of the precipitate earlier in the process. In order to determine the exact extent to which such treatment is of industrial importance, a series of experiments were carried out in the laboratory, and later in the Experimental Factory.

I.—*Laboratory Experiments.*—The experiments in the laboratory extended from Series A to Series U, in each of which from three to six mechanical treatments or combinations of mechanical treatments with constant chemical treatment were compared. There were four methods of mechanical treatment. For comparative purposes only, these will be described as follows :—

(*a*) *Gentle stirring* as obtained with a small laboratory stirrer motor, drawing 7 watts under full load, rotating a glass rod slightly bent at the end at 80 r.p.m. (*b*) *Medium stirring* as obtained with similar equipment with the motor working under full load, giving a well defined but not violent swirl. (*c*) *Violent stirring* produced by a "Cenco" type high speed turbine stirrer. It consists of a vertical shaft with three 3-bladed propellor-like rotors revolving within a cylindrical casing. During operation, the liquid level in the casing is raised 2 ft. 3 in. Circulation is set up by the provision of a suitable opening in the casing through which the liquid flows back to the container. Not only is thorough high speed mixing obtained, but a further factor is the wear and tear on the flocs brought about by the rotor blades. (*d*) *Compressed air* was derived from a small, water-operated blower. The volume of air obtainable was not wholly adequate for proper mixing.

The constant chemical treatment was such that a suitable precipitate of calcium phosphate was obtained. It consisted of adding the same amount of lime water and, at times, of phosphoric acid to the same volume of solution in each of the same series and of heating in a standard manner. The heating was carried out with one 550-watts immersion heater and one large Bunsen burner for each beaker containing 750 ml. of solution.

In Series *A* and *B*, observations were made on a precipitate of calcium phosphate produced from pure solutions. The phosphoric acid solution was prepared from 89 per cent. H_3PO_4 ; it was of such strength that the final concentration of P_2O_5, had no precipitation taken place, would have been 0·03 grms. per 100 ml. Flocs of calcium phosphate were obtained by the addition to a reaction of *pH* 8·0 of filtered, saturated calcium hydroxide solution.

Series *C* and *D* were a repetition of *A* and *B*, except that sucrose was present in amounts roughly corresponding to a high purity and to a low purity mixed juice. In Series *E*, *F* and *G*, the precipitation was carried out in a solution of molasses made up to 80 purity and 0·03 grm. P_2O_5/100 ml. Series *J*, *K*, *L* and *M* were a further repetition of *A* and *B* except that varying amounts of kieselguhr were added before the addition of the lime water.

Series *N* repeated the kieselguhr addition, but the solution used was one of molasses of similar composition to that used in Series *E*, *F* and *G*. Series *O*, *P*, *Q*, *R*, *S*, *T* and *U* were experiments performed on cane juice from the laboratory mill. Different varieties were examined using different clarification procedures. Precipitates were obtained by the addition of 80-mesh 10° Baumé milk-of-lime and by heating in the manner described above.

Observations on each treatment in each series of the laboratory experiments were made so that the

[1] Sugar Technologist. [2] Asst. Sugar Technologist.

rate of settling could be graphed; 600 ml. Pyrex tubes in a pre-heated insulated settling box were employed for this purpose.

II.—*Laboratory Results.*—The rate-of-settling curves so obtained were about 90 in number. Hence, for the sake of brevity, it is proposed to state the general conclusions drawn therefrom without presenting the actual curves.

In the pure solution Series *A* and *B*, it appears that the more gentle the stirring during the addition of the saturated calcium hydroxide solution and during heating, the higher the rate of settling and the smaller the final volume of settled particles. Extending the period of settling to 24 hours does not affect the relative volumes of the settled particles resulting from the different treatments. The characteristics imparted to the flocs are therefore of a permanent nature.

When sucrose is added as in Series *C* and *D*, the viscosity and density of the mother-liquor is increased. At the lower level of sucrose (7·4 per cent.) the flocs settle quite evenly and the final volume is about the same (10 per cent.) as in *A* and *B*. Also, the more gentle the treatment, the greater the rate of settling, but the differences are not so well marked as in *A* and *B*. At the higher sucrose level (15 per cent.) the effect of viscosity and density is such that part of the precipitate forms a scum and the rest a mud. With medium stirring during both the lime addition and the heating, the tendency to form scum is so well marked that the whole precipitate rises to the surface. It then slowly breaks off particle by particle and settles out. At the end of 30 minutes about 30 per cent. of the precipitate is still in the form of scum.

The precipitation of calcium phosphate in the presence of a molasses solution (Series *E*, *F* and *G*) appears completely to alter the mechanical characteristics of the flocs. The result of the four series may be stated as follows: The more violent the stirring during the addition of lime, the greater is the rate of settling. Once the flocs are formed, however, the amount of wear and tear which they can withstand is limited. Violent stirring during liming and medium stirring during heating generally gives the quickest settling and smallest mud volume. If violent stirring is used during heating, the rate of settling decreases and the mud volume increases. Small particle fragments float about in the mother-liquor for a considerable period and appear reluctant to settle.

Attempts to increase the rate of settling of the particles by the addition of kieselguhr before precipitation (Series *J*, *K*, *L* and *M*) were not wholly successful, and no definite conclusions can be drawn. Similarly, in a molasses solution (Series *N*) the addition of kieselguhr has no beneficial effect on the rate of settling except when wear and tear are absent, i.e., when violent stirring is not used.

When juice from the variety B 726 (Series *O* and *P*) is subjected to comparative treatments, it is apparent that violent stirring, during either or both of the lime addition and the heating, results in a slower rate of settling and larger mud volumes. Medium stirring during both, or compressed air during liming and medium stirring during heating, gives the best results.

Juices from other varieties, BH 10 (12) and POJ 2878, behave in a similar manner (Series *Q* to *U*). The use of violent stirring during the secondary liming and heating of F.L. & D.H. with POJ 2878 juice is extremely detrimental, whatever treatment may have been given in the primary stage. It appears that violent stirring during the primary stage and medium stirring during the secondary stage is the best combination from the mechanical point of view.

The above results provide ample evidence that in the laboratory mechanical treatment can materially affect the characteristics of flocs produced by a constant chemical treatment.

III.—*Factory Experiments.*—The existing equipment at the liming and heating stations of the Experimental Factory consists of three cylindrical, conical-bottom liming tanks, each with a "Helico" high-speed stirrer. The juice is delivered by gravity flow from the liming tanks to a juice heater pump supply tank. The pump is of the three-throw, single-acting, reciprocating type. There is one low velocity heater and one high velocity heater.

High speed mechanical agitation was therefore provided by a "Helico" outfit. A more gentle form was obtained by a manually operated paddle. With the small volume of juice (about 38 cub. ft.) to be dealt with, the degree of agitation which resulted was approximately equivalent to that obtained by slow speed mechanical stirring with a larger volume of juice. A third form of agitation was installed for the experiment by fitting one of the tanks with compressed air stirring.

No variation in mechanical treatment could be given after liming, i.e., after the formation of the calcium floc, and before heating. Efforts were made to obtain a suitable centrifugal juice heater pump to determine the effect that this type had on the already formed calcium floc, but unsuccessfully.

Juice for the experiments was obtained by grinding cane of the same variety from the same part of a field. Three liming tanks full were required for each series. The same quantity of milk-of-lime at 15° Bé. was added to each tank full of juice. The mean *pH* values of the clarified juice thus obtained varied from 7·07 to 7·12. In the first treatment of a series, mixing was obtained by the use of the "Helico" stirrer, in the second by the manually operated paddle, and in the third by the use of compressed air.

The milk-of-lime was added incrementally as the tank filled. Stirring was continued for the whole of

the time that each tank was filling and emptying. The rate of emptying was regulated to keep pace with the juice-heater pump, so that the juice was in actual agitation the whole time prior to heating. Heating was carried out by pumping the juice through the heaters operating in series. A temperature of 215°F. was maintained. Careful samples were taken of each batch of raw juice and of the clarified juice derived therefrom. The samples were submitted to standard methods of analyses.

IV.—*Factory Results.*—The mean of the essential analytical results are appended in the following table :—

	"Helico"	Manual	Comp. Air.
Raw Juice :			
Gravity purity	81·980	82·480	82·480
Ash % total solids	1·376	1·213	1·149
Calcium % total solids....	0·214	0·201	0·193
Clarified Juice :			
Gravity purity	84·190	83·720	83·550
Ash % total solids	1·336	1·146	1·161
Calcium % total solids....	0·282	0·260	0·273
Turbidity C.S.R. units....	0·270	0·290	0·270

The rate-of-settling curves are shown in Fig. 1. In order that the differences between the treatments may be emphasized, the following table sets out the

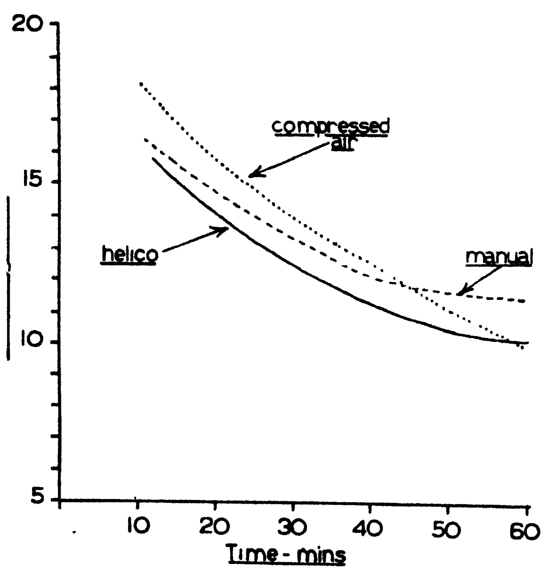


Fig. 1.

gravity purity rise, ash elimination and calcium increase from raw to clarified juice in each treatment :—

	"Helico"	Manual.	Comp. Air
Gravity purity rise (Clar.-raw) ..	2·21	1·24	1·07
Ash elimination (% Ash in raw)	2·91	5·52	—
Ash increase (% Ash in raw)....	—	—	1·04
Calcium increase (% Ca in raw)..	31·60	29·40	41·50
Turbidity, C.S.R. units	0·27	0·29	0·27

In considering these results it should be remembered that, as already pointed out, manual stirring with the small volume of juice used is considered approximately equivalent in degree of agitation to slow speed stirring with larger volumes of juice. As regards "Helico" stirring, when the tank has more than half the volume of juice in it, the effect is to produce a well defined swirl. The action cannot be described as violent, since the tank could have been filled very nearly to the brim without overflowing due to the action of the stirrer.

The reasons why different mechanical treatments should show such well defined chemical differences are difficult to explain satisfactorily. It is apparent however that, of the three treatments, compressed air gives the poorest results. On the other hand, the "Helico" stirrer produces the highest gravity purity rise, while manual stirring shows the greatest ash elimination. It appears likely that, since ash elimination is less with the "Helico" than with the manual stirring, the greater gravity purity rise is due to the precipitation of more organic non-sugars.

The *increase* in ash from raw to clarified juice with compressed air stirring is the only instance recorded in any series of experiments at the Experimental Factory during the whole of the research work. The juice used in this particular series is comparable with that used for the other treatments. AMBLER[1] states that there is little doubt but that oxidation of tannins, polyphenols and invert sugar takes place when limed cane juice is "blown up" with compressed air. It is known that the oxidation products of invert sugar when combined with calcium form soluble complexes, because they are the cause of the typical reddish-brown colour of an alkaline juice.

The position with regard to the tannins and polyphenols is more obscure. ZERBAN[2] has isolated them from cane juice and states that the polyphenol of the sugar cane is not pyrocatechin but a true tannin, closely resembling the oak tannins. These are soluble in alkaline solution, and hence it would suggest that soluble calcium complexes would also be formed. The exact extent to which these particular reactions take place on a factory scale is difficult to assess, but the present results indicate that the combined effects of all the reactions produced by the use of compressed air are not only measurable, but are of industrial importance. The purity rise with compressed air mixing is smaller than with either of the other methods, there is an ash increase instead of an elimination, and the calcium increase is definitely greater. The three observations are in corroboration.

It will be remembered that in the laboratory experiments with cane juice there were no well defined differences in rate of settling as long as the treatment after floc formation was not violent.

[1] *J. Ind. Eng. Chem.*, 1930, **22**, p. 357.

[2] *Ibid.*, 1919, **11**, p. 1034.

Examination of the figure shows that with this factor constant there is also little difference in the final mud volumes obtained on a factory scale. The curve for rate of settling of the compressed air treatments had to be smoothed out a good deal because the readings in each experiment showed that the level of the mud rose and fell periodically. This action was not observed with the other two treatments, and may be in some way connected with possible aeration. For the whole of the 60 minutes during which observations were taken, the compressed air treated juice seemed reluctant to settle. At the end of that period it had not yet got to the stage of attaining a more or less constant volume. Both of the other treatments settled quite readily, with a continuously decreasing volume of mud.

V.—*Conclusion.*—It would appear that mechanical treatment of the juice can affect the result of the clarification process as carried out on a factory scale. High speed ("Helico") stirring during the lime addition results in the highest gravity purity rise, but slow speed (manual) stirring produces a better ash elimination. The increase in calcium from raw to clarified juice is about 30 per cent. in each case. With compressed air stirring, the gravity purity rise is smaller than with either of the other two mixing methods. Also, there is an ash increase, as opposed to the usual decrease in clarified juice, together with an appreciably greater increase in calcium. The mud after compressed air treatment settles erratically. The final volume after 60 minutes settling is, however, of the same order as that obtained with the other mixing methods.

According to the earlier laboratory work, it is expected that more profound differences are obtainable, at any rate as regards rate of settling, if the treatment after the formation of the calcium floc can be varied. Such variation, which, it is thought, produces increased mechanical wear and tear of the flocs, is obtained by the use of a centrifugal juice heater pump instead of the existing reciprocating type.

Acknowledgment of the work of Mr. J. DUNLOP, 3rd year student, in obtaining the rate of settling data is made with appreciation.

Evaluation of Cane Varieties in South Africa.

By G. M. COATES and V. M. HINCHY.[1]

Uba cane had for 50 years been the only cane grown in South Africa, and a system of payment for this cane at the factories had been worked out, based on the sucrose content of the first crusher juice and the Java ratio at each factory. With the introduction of new varieties from Java and Coimbatore, and the commencement of deliveries on a large scale to the factories, the problem of the "additional value" of these canes became one of prime importance.

The particular characteristics claimed for these non-Uba canes as compared with Uba were: (*a*) lower average fibre content of cane; (*b*) higher average purity of juice; and (*c*) higher average sucrose content. It was contended that lower fibre gave increased extraction, higher purity gave higher boiling-house recovery, and that a combination of these two factors with the third—higher sucrose content—meant higher rate of output from the factory per unit of time. These advantages obtained by milling superior quality canes were considered to constitute "additional value" and, accordingly, a system was devised for calculating in terms of the price of Uba the value of each of the new varieties.

Fibre Content of Non-Uba Canes.—It was necessary, first of all, to establish that since the introduction of the non-Uba canes there had been a decline in the average fibre content of the cane crushed at the factories. Consignments of cane delivered to the mills are not separately tested for fibre. It is, therefore, not possible to prove by direct evidence of mill records that the supplies of Uba cane to the mills are of higher fibre content than those of non-Uba. But information is available from which it must be inferred that this is a fact.

The average fibre content of cane supplied to all mills from 1926 to 1935 (excluding 1934, the locust year) was 15·84 per cent. This is an average of at least 25 million tons of Uba cane. Since 1935 increasing quantities of non-Uba have been delivered to the mills, and the average of the four years, 1936 to 1939, has fallen to 14·87 per cent. This is the average of over 18 million tons of mixed variety cane, of which approximately 50 per cent. was Uba and 50 per cent. non-Uba. It is suggested that the

Year.	Fibre per cent. Cane.	Year.	Fibre per cent. Cane.	Approx. Proportion non-Uba.
1926 ..	16·01	1936 ..	15·01	30%
1927 ..	16·27	1937 ..	15·14	40%
1928 ..	15·88	1938 ..	14·51	50%
1929 ..	15·52	1939 ..	14·81	70%
1930 ..	15·82			
1931 ..	15·75			
1932 ..	15·65			
1933 ..	15·78			
1935 ..	15·92			
Average:	15·84	Average:	14·87	

[1] Of the South African Cane Growers' Association, Durban.

reduction was due to non-Uba, and the evidence for this becomes stronger when the annual figures between 1926 and 1935 are compared with the annual figures of 1936 to 1939. These are set out in Table above.

Since the tendency in recent years has been to prolong the season, and thus to crush cane during periods when fibre is abnormally high, the average figures reported for 1936 to 1939 would have provided a greater contrast with the averages for 1926 to 1935 if the seasons had been the same length throughout the period under review. In illustration of this point, the fibre content in January, 1939, was 15·92 as against an average from May to December of 14·73.

Non-Uba represented approximately one-half of the total of over 18 million tons delivered in the period 1936 to 1939. This raises the presumption that the fibre content of the new varieties taken as a whole was two units less than the fibre content of the Uba included in the total.

It was necessary, however, to determine the difference between the fibre per cent. cane of Uba and that of each non-Uba variety. This could not be done from mill records, but as a result of experimental work carried out over a period of years by the Sugar Experiment Station, Mount Edgecombe, data were available from which average values of the fibre content of the canes could be deduced, and thus the differences of each variety from Uba obtained. These differences having been ascertained, and knowing the total fibre in a given quantity of cane and the proportion of each variety in that quantity, the fibre percentages of the varieties were determinable by a simple calculation.

The Experiment Station tests showed the differences in fibre content from Uba of each of the new varieties to be as follows :—

Variety.	Difference from Uba.
Co 281	—0·32
Co 301	—1·30
Co 290	—1·51
POJ 2725	—2·25

Sucrose and Purity of Non-Uba Canes.—Evidence of the average sucrose content of the varieties was forthcoming in the records of the Sugar Industry Central Board. This Board maintains a staff at each of the mills to test samples of the first crusher juice obtained from each consignment of cane. From the observed sucrose in the juice, the sucrose content of the cane is calculated by application of the Java ratio factor, and weekly weighed averages are recorded separately for each variety. Arithmetical averages of these weekly results were used because there is a marked difference in the proportionate quantities of the several varieties crushed at different periods of the season; and, since there is seasonal as well as varietal variation, if a weighted average for the whole season were to be used the quality of these varieties of which a large quantity was crushed during the optimum months would be disproportionately high.

The average purities of first mill juice of the varieties were calculated arithmetically also from the Central Board results, and a factor 0·97 (generally accepted in South Africa) was used to convert these purities to terms of the mixed juices.

Thus were obtainable the necessary data regarding each variety of cane from which the additional values of these canes could be calculated.

Three Factories as Example.—The results of three large milling plants only were taken for the purposes of the calculation, for the following reasons. It was their "capacity to pay" which originally determined the price of Uba sucrose; they draw their supplies of cane almost entirely from independent planters; they are mainly interested in milling, as distinct from cane growing, so their profits depend on their achievement in milling; new variety canes form a larger proportion of their total than with other mills and they were the only ones having an appreciable quantity of POJ 2725; they make cargo sugar only and there is no white sugar in their total to complicate matters; certain essential data are available in connexion with their cane supply which are not available at all mills.

The average analyses of the varieties of cane during three years (1937 to 1939 inclusive) at these three mills are as follows :—

	Uba.	POJ 2725.	Co 281.	Co 290.	Co 301
Fibre % Cane	15·46	13·21	15·14	13·95	14·16
Sucrose % Cane ..	12·87	14·74	13·79	13·46	13·01
Purity, Mxd. Juice	84·18	86·75	86·61	85·27	85·47

Calculation of Overall Recoveries.—The manufacturing results of the three factories during the same period were :—

Fibre per cent. Cane	14·55
Extraction	93·02
Juice lost per Unit of Fibre ..	41·03
Purity of Mixed Juice	85·96
Boiling-house Recovery	88·68
Virtual Purity of Molasses	40·94
Overall Recovery	82·49

Substituting for the average fibre per cent. cane the particular fibre content of each variety in turn in the equation: $\text{Extraction} = 100 - \dfrac{\text{Juice loss} \times \text{Fibre}}{100 - \text{Fibre}}$

a series of extractions equivalent to the respective fibre content were obtained. Similarly by substituting the purities of the individual varieties in the equation

$$\text{B.H.R.} = 10{,}000 \times \frac{\text{Purity} - \text{Virtual Pur. of Molasses}}{\text{Purity}\,(100 - \text{Virtual Pur. of Mol.})}$$

the B.H.R. for each variety was obtained. The overall recovery for the varieties was then obtained simply by multiplying the Extraction by the B.H.R.

The results were as follows :—

	Uba.	POJ 2725.	Co 281	Co 290.	Co 301.
Extraction	92·52	93·76	92·68	93·35	93·24
Boiling-house Rec.	86·97	89·41	89·29	88·03	88·22
Overall Recovery	80·46	83·83	82·75	82·18	82·26
Ditto, diff. from Uba		+3·37	+2·29	+1·72	+1·80

It is now a comparatively simple matter to evaluate the extra recovery attributable to each variety.

The quantity of sucrose in cane of any variety required to make a ton of sugar will obviously be :

$$1 \text{ ton} \times \frac{100}{\text{Variety O.R.}} \times \frac{\text{Pol.}}{100}$$

Taking 98·7 as the polarization usually adopted for the South African sugar industry and applying the formula to a particular variety, say Uba, the quantity of the raw sucrose required will be :

$$1 \text{ ton} \times \frac{100}{80{\cdot}46} \times \frac{98{\cdot}7}{100} = 1{\cdot}22670 \text{ tons}$$

and in the same way for the other varieties :—

	Tons.		Tons.
POJ ..	1·17738	Co 290 ..	1·20102
Co 281 ..	1·19275	Co 301 ..	1·19985

Calculation of Recovery Values.—If the value of 1 ton of raw sucrose is £5. 5s. 0d., the cost to the manufacturer of 1·22670 tons will be £6·74685—this is the cost of the amount of sucrose from Uba required to make 1 ton of sugar. The additional value of the other varieties will be the difference between £6·74685 and the cost of the required sucrose from each variety. This is stated per ton sugar as follows :—

POJ £6·74685 — (£5/5/0 × 1·17738) = £6·74685 — £6·47559 = £0·27126

Co 281 £6·74685 — (£5/5/0 × 1·19275) = £6·74685 — £6·56012 = £0·18673

Co 290 £6·74685 — (£5/5/0 × 1·20102) = £6·74685 — £6·60561 = £0·14124

Co 301 £6·74685 — (£5/5/0 × 1·19985) = £6·74685 — £6·59917 = £0·14768

To convert the additional value into terms of sucrose it is but necessary to divide the values given above by the equivalent tons of sucrose per ton of sugar for each variety, thus :—

POJ $\frac{£0{\cdot}27126}{1{\cdot}17738}$ = £0·23039 = 4·19% expressed as per cent. of base price of Uba sucrose.

Co 281 $\frac{£0{\cdot}18673}{1{\cdot}19275}$ = £0·15655 = 2·85% expressed as per cent. of base price of Uba sucrose.

Co 290 $\frac{£0{\cdot}14124}{1{\cdot}20102}$ = £0·11760 = 2·14% expressed as per cent. of base price of Uba sucrose.

Co 301 $\frac{£0{\cdot}14768}{1{\cdot}19985}$ = £0·12308 = 2·24% expressed as per cent. of base price of Uba sucrose.

Capacity Values.—This proportion of the total additional value of the non-Uba canes has been termed the "Recovery Value." There is also what is known as "Capacity Value" because, by virtue of the superior qualities of the non-Uba canes, it has been found possible to increase the output of the factory per unit of time and thus decrease the cost of production per unit weight of sugar.

It is stated that the primary factor controlling the rate of out-turn of sugar is the rate at which the sucrose enters the factory, and this rate is dependent upon the sucrose and fibre content of the cane. The controlling factor in efficient milling is the fibre throughput per hour, and while crushing a cane of high fibre content the input of sucrose is reduced compared with a cane of low fibre containing the same percentage of sucrose. Further, it is evident that with canes of equal fibre the tonnage of sucrose reaching the boiling-house per unit of time is greater in the case of the cane with the higher sucrose content. In fact, the situation may be summed up thus :

$$\begin{matrix}\text{Tons sucrose}\\ \text{input}\\ \text{per hour}\end{matrix} = \begin{matrix}\text{Tons fibre}\\ \text{throughput}\\ \text{per hour}\end{matrix} \times \frac{\text{Sucrose per cent. cane}}{\text{Fibre per cent. cane}}$$

In the end the limiting factor is, of course, the capacity of the boiling-house to deal with the raw material.

Since tons sugar output = tons sucrose input × $\frac{\text{Overall recovery}}{\text{Pol. of sugar}}$ the capacity of the factory in terms of sugar manufactured is simply :

$$\begin{matrix}\text{Tons fibre throughput}\\ \text{per hour}\end{matrix} \times \frac{\text{Sucrose per cent. cane}}{\text{Fibre per cent. cane}} \times \frac{\text{Overall recovery}}{\text{Pol. of sugar}}$$

In illustration of this, the results of one of the three factories are quoted below for the successive months of the 1939-40 crop, and it will be seen that as the value of the quotient $\frac{\text{sucrose per cent. cane}}{\text{fibre per cent. cane}}$ increases, the raw sucrose input increases and the sugar output increases also.

There is, of course, the monthly increase up to the peak, and decrease therefrom of the overall recovery, due to the effect of seasonal changes on the fibre content of the cane and the purity of the juice, but the sucrose-fibre quotient is obviously the chief factor determining the rate of sugar output.

Manufacturing Costs.—The effect of the change over from Uba (previous to 1935) to non-Uba has been not only to reduce manufacturing costs but, by virtue of increased earning power, to add to the capital value of the mills. The latter factor, however, is so difficult to assess that no attempt will be made to do so and instead merely the reduction in manufacturing costs will be determined.

A factory is limited in its operations to a certain portion of the calendar year which is known as the "crushing season." In that season there are a certain

Month.	Sucrose per cent. cane.	Fibre per cent. cane.	Quotient Sucrose per cent. cane / Fibre per cent. cane	Tons raw sucrose per hour.	Tons sugar per hour.	Per cent. increase in quotient Compared to minimum.	Per cent. increase in output
May	11·72	14·97	0·78	8·16	6·78	1·3	3·0
June	12·95	14·72	0·88	9·22	7·80	14·3	18·5
July	13·51	14·39	0·94	9·82	8·51	22·1	29·3
August	14·22	14·42	0·99	10·28	8·87	28·6	34·8
September	14·30	14·37	1·00	10·42	9·09	29·9	38·1
October	14·40	14·96	0·96	10·48	9·03	24·7	37·2
November	13·91	14·67	0·95	9·96	8·39	23·4	27·5
December	13·17	15·13	0·87	9·51	7·87	13·0	19·6
January	12·24	15·83	0·77	8·47	6·58	—	—

number of "working hours" and in consequence the available working time for the year is limited. The total costs of the factory for the season are those of the financial (calendar year) and they may be subdivided into fixed and variable costs. The fixed or establishment costs remain constant in every season, such costs as depreciation and interest on capital. The variable costs are those which vary with output, as for instance, bagging materials, chemicals, and other manufacturing requisites.

To ascertain the fixed costs per working hour of the factory, the total fixed costs must be divided by the total number of working hours in the season. Further, to determine the fixed costs per ton of sugar it is only necessary to divide the fixed costs per working hour by the sugar output per hour.

In order to determine the additional value of the non-Uba varieties due to reduction in manufacturing costs, it is necessary to calculate the sugar output per hour from each variety of cane. Since the cane sent to the mills is invariably mixed, no direct information is forthcoming, but it is possible by use of the data already ascertained to calculate the output from each variety separately.

The first stage is to determine the Overall Recovery of each variety, say for the year 1939. This is calculated from the standard difference between the Average Overall Recovery of all canes for the 1937-39 period, the Overall Recovery for the variety during that period, and the Average Overall Recovery for the season, thus :—

Overall Recovery 1937-39—	Uba.	POJ	Co 281	Co 290	Co 301
All canes	82·49	82·49	82·49	82·49	82·49
Do. each variety	80·46	83·83	82·75	82·18	82·26
Difference	—2·03	+1·34	+0·26	-0·31	—0·23
Overall Recovery 1939—					
All canes	82·67	82·67	82·67	82·67	82·67
Do. each variety	80·64	84·01	82·93	82·36	82·44

From the Central Board Testing Service the following details were obtained :—

AVERAGES OF THE 1939 CANE CROP AT THESE THREE FACTORIES.

	Uba	POJ	Co 281	Co 290	Co 301	Avg.
Sucrose % Cane	12·37	14·18	13·32	12·86	12·80	13·14
Fibre % Cane	15·72	13·47	15·40	14·21	14·42	14·74

The average rate of fibre throughput per hour for these factories is 11·62 tons, so that all information is now available to determine by use of the formula below the output from each variety :—

$$\text{Tons sugar per hr.} = \text{Tons fibre per hr.} \times \frac{\text{Sucrose per cent. cane}}{\text{Fibre per cent. cane}} \times \frac{\text{O.R.}}{\text{Pol. sugar}}$$

	Uba.	POJ	Co 281	Co 290	Co 301	Avg.
Tons sugar per hr. :	7·47	10·41	8·44	8·77	8·61	8·68

Fixed Costs.—The problem of determining the fixed costs per hour to anyone for whom the financial accounts of the factories remain closed books is extremely difficult but may not be considered insoluble. Some data are available from which reasonably accurate costs may be obtained, and since it is not the exact cost which is required but primarily the difference in cost from Uba, the margin of error is considerably reduced.

The Board of Trade and Industries' Accountant in 1935 reported that total milling costs per ton of sugar consisted of :—

1.	Wages and salaries	17s. 0d.	
2.	Rations and other expenses	1s. 8d.	
3.	Manufacturing requisites	7s. 3d.	14s. 11d.
4.	Fuel and oils	2s. 3d.	
5.	Bagging materials	5s. 5d.	
6.	Maintenance materials	7s. 1d.	
7.	Sundry expenses at mills	1s. 0d.	
			£2. 1s. 8d.
8.	Depreciation		8s. 4d.
9.	Administration		7s. 4d.
10.	Interest on capital at 5%		7s. 2d.
	Total		£3. 4s. 6d.

Of this total certain items may be considered to vary in direct ratio to output. It is assumed that the total of these items amounts to 15s. 0d. per ton of sugar (actually 14s. 11d.), and the balance may be termed fixed costs, a sum of £2. 9s. 6d. per ton of sugar. Thus the fixed costs in 1935, when 82,279 tons of sugar was the total manufactured by these three factories, amounted to £203,640 for the year. Fixed costs per working hour can now be calculated, viz. :—

Year.	Fixed Costs.		Total Working Hours.		Cost per hour.
1935	£203,640	÷	11,024	=	£18. 9s. 5d.
1936	£203,640	÷	11,228	=	£18. 2s. 9d.
1937	£203,640	÷	12,294	=	£16. 11s. 3d.
1938	£203,640	÷	12,736	=	£15. 19s. 9d.
1939	£203,640	÷	14,861	=	£13. 14s. 0d.

The number of hours worked in 1939 indicated clearly that these factories worked to full time capacity in that year and could not have reduced their fixed costs further by lengthening the crushing season.

The fixed costs per ton of sugar in 1939 were therefore $\frac{£13.\ 14s.\ 0d.}{8{\cdot}68}$ = £1. 11s. 7d. If Uba only had been crushed in 1939, the fixed costs would have been $\frac{£13.\ 14s.\ 0d.}{7{\cdot}47}$ = £1. 16s. 8d., a difference of £0. 5s. 1d. per ton of sugar made.

It is now possible to assess the additional value of each variety of cane compared with Uba on the score of reduction in fixed costs per ton of sugar and per ton of raw sucrose :-

	Cost per ton of sugar	Difference from Uba	Tons sucrose to tons sugar.	Additional value per ton of sucrose	Expressed as per cent. of base price of Uba sucrose.
POJ :— $\frac{£13.\ 14s.\ 0d.}{10{\cdot}41}$	£1·31604	£0·51796	1·17738	£0·43992	8·00
Co 281 :— $\frac{£13.\ 14s.\ 0d.}{8{\cdot}44}$	£1 62322	£0·21078	1·19275	£0·17672	3·21
Co 290 :— $\frac{£13.\ 14s.\ 0d.}{8{\cdot}77}$	£1·56214	£0 27186	1·20102	£0·22636	4·12
Co 301 :— $\frac{£13.\ 14s.\ 0d.}{8{\cdot}61}$	£1·59117	£0·24283	1·19985	£0·20238	3·68
Uba :— $\frac{£13.\ 14s.\ 0d.}{7{\cdot}47}$	£1·83400	—	—	—	—

Total Additional Value.—To summarize, the total additional value of the non-Uba canes per ton of sucrose may be stated thus :—

	POJ	Co 281	Co 290	Co 301
Recovery Value..	£0·23039	£0·15655	£0·11760	£0·12308
Capacity Value ..	£0·43992	£0·17672	£0·22636	£0·20238
Total Value ..	£0·67031	£0·33327	£0·34396	£0·32546

Expressed as a percentage of £5. 5s. 0d., the base price of Uba sucrose, the total additional value becomes :

12·19% 6·06% 6·25% 5·92%

or, in terms of 1 ton of cane of 13 per cent. sucrose :

1s. 9d. 10½d. 11d. 10½d.

Since the average sucrose content of the non-Uba canes in 1939 was as follows :

14·74 13·79 13·46 13·10

the actual additional value per ton of each variety amounted to :

1s. 11¾d. 11d. 11½d. 10½d.

Conclusion.—It has thus been possible to determine the effect of replacing Uba by Coimbatore and Java canes at the factory. On the basis of the Noël Deerr formulae used by him primarily to determine Reduced Extractions and Reduced Boiling House Recoveries,[1] the actual Overall Recoveries from each variety have been calculated. It should be noted that the additional recovery claimed as being attributable to non-Uba cane was but a small proportion of the extra recovery attained by these mills since the introduction of non-Uba in 1936. The balance was admittedly due largely to factory improvements during the period 1936 to 1939.

The problem of determining the reduction in "fixed costs" of manufacture has been solved by calculating the increased tonnage of sugar outturned per hour from each non-Uba variety compared with the outturn from Uba cane only.

The deleterious effect of the presence of the inferior Uba in the cane proceeding to the mill and in the juice proceeding to the boiling-house in the inevitable mixture of supplies has not been assessed, as this is an extremely complicated problem. Ease of manufacture from non-Uba cane, less wear and tear of milling plant and lower maintenance costs in consequence are all recognized features of the milling of low fibre, high purity and high sucrose canes, but the practical determination of the cash values of these advantages is no simple matter. Nor has the effect of increased output on such variable costs as chemicals, fuel and oil been taken into consideration, so that the additional values claimed above may be considered to be the minimum.

[1] See *I.S.J.*, 1933, p. 214.

Oil Grooving of Mill Brasses.

By D. BURNS CAMPBELL, A.M.I.Mech.E.

The very important yet badly neglected subject of oil grooving in mill brasses is taken up by the writer because he feels that much trouble and many breakdowns could be averted by just a few simple suggestions coupled to a little commonsense reasoning.

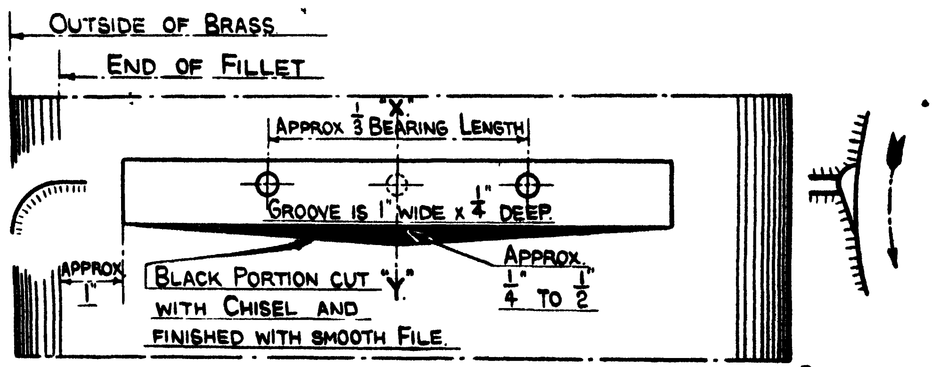
Efficient lubrication is more necessary than ever to-day because of the ever-increasing loads to be sustained by mill roll necks or journals; and though lubricants are now better suited and better elaborated from crudes, they will be wasted unless a simple and yet fully effective system of oil groove is cut into the brass at the proper place for the distribution of the lubricant over the pressure area.

From what the writer has seen in many sugar factories it would appear that the value of well-placed grooving in mill brasses is not yet reasonably appreciated. In quite a number of factories the cutting of these grooves is left to a native mechanic, who seems to think that the more grooves he can criss-cross over the surface of the bearing, the cooler the brass will be. Nothing could be farther from the truth, as proved time and time again. Oil grooves for mill brasses must *not* be cut in the pressure area because this part has to sustain the load, and if grooves are cut here the film of lubricant which keeps the journal and brass apart will be broken down by being squeezed back into the grooves, and so it is proved that such grooves defeat the end desired and allow the metal of the journal to rub against the brass with resultant heating and wearing away of the parts in contact.

The accompanying sketch shows a very efficient yet simple style of groove which has served for introducing the lubricant with an absolute minimum amount of oil necessary for effective lubrication.

The slight widening of the oil wedge towards the centre of the brass is purposely made so in order to have the lubricant flow towards the centre, from whence it will be drawn into the pressure area by the rotation of the journal and then made to spread over this area before it is finally squeezed out towards the sides.

The writer suggests that, for small brasses, the oil hole into the groove should be in the centre of the brass, and where two oil holes are necessary for the larger brasses, these should be placed nearer to the centre than to the ends. It has been observed that when oil holes into the groove are placed near the ends, the oil is drawn into the bearing only at these zones, leaving the centre part comparatively dry.



- SPECIAL OIL GROOVE FOR MILL BRASSES. - SECTION THROUGH "X"-"Y".

These grooves should be located about 45 to 55° from the point of maximum pressure and in front of the pressure area with reference to the rotation of the shaft.

If this system is adopted, the old grooves should be filled in with white metal in order to maintain the continuity of the bearing surface.

Lubricant issuing from the ends and down the headstocks is a sure indication that the feed can be materially reduced. With this system of oil wedge, as against the cross grooving in the pressure area, the writer has no hesitation in saying that a 50 per cent. economy of lubricant can be obtained, and at the same time the juice will not be contaminated by excess of oil, whilst the headstocks will present a cleaner appearance.

The selection of a good grade heavy-bodied lubricant[1] for this class of work is very necessary, and the time spent in its selection, after testing under working conditions, is well repaid.

[1] See author's article "Efficient and Economic Lubrication," *I.S.J.*, 1934, pp. 66-69.

One's desire is to help fellow engineers to have trouble-free milling plants, and if the lubrication in all sections is effective, lengthy shutdowns are avoided and repair bills greatly reduced.

For grease lubrication of the roller necks the same style of groove can be used, but it should be deeper and broader; and the lubricator should be of the constant pressure feed type.

It has been proved that grease under pressure gradually solidifies; therefore, in the case of grease lubrication, the groove in the brass should be equipped with an arrangement whereby it can be kept open by forcing hot water, steam, or compressed air through the conduits. The writer kept an Alemite Volume Compressor filled with heavy oil, and once a week hooked this to each bearing and forced oil through. This helped to remove any obstruction and at the same time kept the surfaces well lubricated.

Analysing the Consumption of Milling Power[1]:

A Discussion of Mr. L. A. Tromp's Paper.

By M. CH. VARONA.

Mr. TROMP's paper on the above subject, presented at the Twelfth Conference of the Association of Sugar Technologists of Cuba,[2] is of outstanding merit and thoroughly covers this too little discussed subject of sugar technology. It is the purpose of the present writer to make a few comments on it.

In his former article "Analysing the Consumption of Milling Power,"[3] Mr. TROMP made no mention of the work of compressing the cane, and merely assumes a friction coefficient of 0·15 between the roll journals and bearings of the milling unit. Mr. J. R. MAYO, Jr., ably discussed that omission in his contribution to the Twelfth Conference of the Association, entitled "Discussion of Mr. TROMP's Theory on the Distribution of Power in Sugar Cane Mills."[4]

Mr TROMP, in the paper now under discussion, terms the work of compression "rolling friction," arriving at a coefficient of 0·29 to represent that expression after coming to the conclusion that the coefficient of 0·15, used in his earlier article, was too low. To the coefficient of 0·29, he adds 0·03 (Varona's coefficient for journal friction), i.e., a total coefficient of 0·32 to be used instead of that of 0·15.

Referring to page 378 of Mr. TROMP's article in the *I.S.J.* for 1936, we find the power worked out for one mill, under the conditions assumed, and using the coefficient of 0·15, to be 203 i.h.p. Substituting the coefficient of 0·32 in working out that example, we have :—

$$2{,}225{,}000 \times 0{\cdot}32 \times 0{\cdot}223 = 158{,}776 \text{ ft. lbs.},$$

where 2,225,000 = total load on roll journals, lbs., 0·223 = peripheral speed journals, ft. per sec., resulting in a power consumption of 288·68 i.h.p.

The power absorbed by the crusher, using the coefficient of 0·15, as worked out on page 379 of the cited contribution is shown to be 126 i.h.p On applying the coefficient of 0·32 to that calculation we have :—

$$900{,}000 \times 0{\cdot}32 \times 0{\cdot}383 = 110{,}304 \text{ ft. lbs.},$$

where 900,000 = total load on roll journals, lbs., 0·383 = peripheral speed of journals, ft per sec., resulting in a power consumption for the crusher of 200 i h.p.

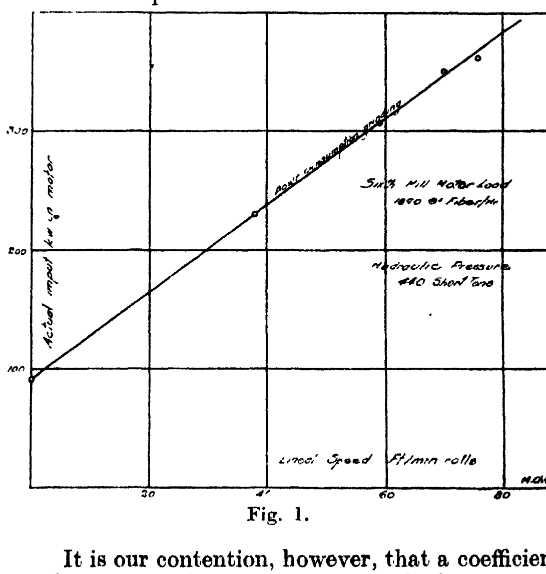


Fig. 1.

It is our contention, however, that a coefficient of 0·32 is too high, because the calculated power is greater than that actually measured, using an indicator under equal milling conditions. In our opinion the discrepancy arises from interpreting the work of compression as "rolling friction."

To our mind, there is no more reason why the work of compressing sugar cane should be termed

[1] *Proceedings of the 13th Annual Conference of the Association of Sugar Technologists of Cuba*, pp. 35-38.
[2] *I.S.J.*, 1939, pp. 18, 58 and 101. [3] *I.S.J.*, 1936, p. 377. [4] *I.S.J.*, 1940, p. 142.

"rolling friction" than there is to term the work **of compressing air** "sliding friction" in a reciprocating compressor, or "rolling friction" in one of the centrifugal type.

The example given by Mr. MAYO in his article,[1] in which he uses a spring compressed between two planks, does in our opinion more clearly illustrate what actually happens in compressing cane.

The curve shown in Fig. 1 was presented by the writer in connexion with an earlier paper entitled "Importance of Speed on the Amount of Liquid handled and on the Power Consumption of Cane Mills" in which we interpreted the *Y* interception of the ordinate of the curve to represent power expended in compressing the cane, which power at zero speed was 90 k.w. at the switchboard.

To convert that k.w. reading to b.h.p. at the mill coupling, it was necessary to take into account the efficiency of the transmission line, which is 0·92, that of the motor, which is 0·93,

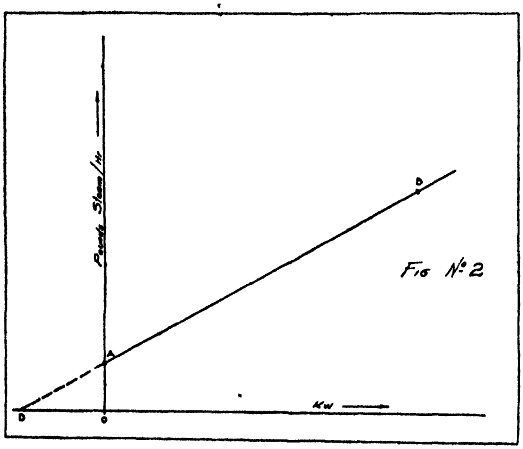


Fig. 2.

and that of the reduction gear, which is 0·97. The high efficiency of the gearing being explained by the fact that it is of the herring-bone precision type of cut gearing.

The 90 k.w. reading at mill coupling then working out :—

$$\frac{90 \times 0{\cdot}92 \times 0{\cdot}93}{746} \times 0{\cdot}97 = 100{\cdot}12 \text{ b.h.p.}$$

The actual power consumption recorded in the foregoing example applied to about the same amount of cane ground per hour, as that assumed by Mr. TROMP in working out the example given in the paper under discussion, in which he arrives at the net milling power requirement of approximately 75 h.p.

Clearly, the assumption that the points of interception on the ordinate of the curve, shown in Fig. 1, represent power expended solely in compressing the cane, is a mathematical one, arising from the coincidence that at zero speed there is no power expended in overcoming friction.

Similar mathematical assumptions creep into other engineering subjects, as will be seen in the following example. On the curve shown in Fig. 2, the points *A-B* show what is known as the Williams Line, used in testing steam turbines. Note that the line is extended to the left after it cuts the ordinate, the distance *O-D* being taken to represent the power expressed in kilowatts needed to run the turbine at zero load. This is as much a mathematical assumption as our calling the *Y* interception on the curve shown in Fig. 1 at zero speed, the power spent in overcoming friction.

There is another reason why the friction load should not be confused with the power expended in compressing the cane. In a paper by the writer, entitled "Predetermination of Power spent in grinding Sugar Cane," published in the Proceedings of the Association,[2] the relation between speed and power consumption per unit of cane fibre ground was graphically shown. That graph demonstrated that, when the speed increases pressure on rolls and amount of cane fibre remains constant, the power expended in overcoming friction also increases.

On the other hand, if the roll pressure and the amount of cane remain constant, the power required for compressing the fibre does not vary with the speed of compression. Consequently, as the blanket of cane fibre[3] decreases, the power expended in overcoming friction increases and the total power expended per unit of fibre ground increases, even though the power expended in compression remains constant.

Expenditure of power in overcoming friction is directly related to cane ground per unit of mill speed, whereas power for compressing cane, with constant roll pressure and mill settings, varies only with percentage of fibre in unit of cane.

MR. L. A. TROMP.—We mentioned last summer, when publishing a paper by L. A. Tromp on the Electrification of Sugar Factories, that we had been without news of him since May 10th when Holland, where he lives, was overrun by the German armies. We now learn from a correspondent in Cuba that news has been received there from him, reporting that down to September 15th he and his family were alive and enjoying good health. One is relieved to learn that this valued contributor to our pages has survived the ruthless attack made on his country, though it is regrettable that he is subjected for the duration of the war to all the limitations imposed on a German-occupied territory. His numerous friends in the sugar industry will, however, be glad to get this reassuring news of his welfare.

[1] *I.S.J.*, 1940, p. 142. [2] *I.S.J.*, 1937, p. 222.

[3] "Blanket Thickness" = Weight of fibre ground per unit of time, divided by roll area presented per unit of time.

Wear under Lubrication Conditions.[1]

According to a definition by GILLETT in 1937,[2] "wear of a part is its undesired gradual change in dimensions in service under frictional pressure." This differs from earlier definitions in that it includes deformation as well as removal of material, a point of importance where soft bearing-metals, for instance, are concerned. Loss by corrosion is not considered as wear, though it may sometimes play an important part in increasing wear.

Wear and Friction.—Wear occurs through contacts, and it thus belongs essentially to the "boundary" section of lubrication. Protection of surfaces being afforded by molecular films of lubricant, both friction and wear are less in the presence of such films than without them. The polar and longer molecules which are more effective in reducing friction have naturally been considered to afford better protection against wear, and the term "oiliness" has come to be widely used in connexion with wear reduction as well as friction reduction, the two features not being distinguished in this use. The definition of oiliness refers, however, to friction only. It may be noted that we have no specific term for the wear-reducing qualities of a lubricant.

It is probable that wear and friction have vaguely been thought to be proportional to each other. Undoubtedly in the general case increase of wear is associated with increase of friction, but in particular circumstances even under dry conditions they are not proportional and cannot be strictly so for conditions of lubrication. Under fluid film conditions with no contact, the wear is nil for a definite, though small, value of friction. When boundary conditions become operative, the friction rises to a much higher value, but the wear remains nil so long as the boundary films afford complete protection for the underlying metals. Then wear of a mild kind may occur to an appreciable extent without the friction varying greatly from its boundary value. When more severe cohesion occurs with tearing of the surfaces, both friction and wear increase to high values, but the relative values are not known.

Fluid Film Conditions.—A qualifying condition to the statement that wear under fluid film conditions is nil lies in the cleanliness of the oil; the bulk of wear in ordinary mechanism may well be due to particles carried in the oil. Bearings, both journal and thrust, are commonly found to be scored, even though they have run under conditions appropriate to a relatively thick film. Air-borne dust is recognized as an important cause of wear of motor-car cylinders and of hot boxes on the railways. Fine particles, too small to be seen and not large enough to cause obvious scoring, can cause continuous fine wear when films are thin. The limit of thickness of films for hydrodynamic behaviour is not known, but it is probably less than 0·00001 inch, beyond the size of visible particles. The filtration of particles even ten times as large as this is a serious problem, though filter elements of the fabric and related types are to some extent effective because the fine particles cling to the second-order fine fibres.

In general, the cleaning arrangements for the oil are already one of the limiting factors to progress in utilizing fluid films, and may continue to be so in the future when thin films are deliberately used, unless some effective development occurs.

Running-in.—The complex of processes comprised in running-in is one of the most vital phases of wear under conditions of lubrication. It represents primarily the adjustment of the surface shapes, both on micro-and macro-scales, to correspond with each other, usually so as to establish fluid film conditions. If the fluid film is not normally thick enough to separate the surfaces beyond the height of the highest points, there will be rubbing. Owing to the concentration of load on the high points and the consequent danger of severe cohesion, there is no question as to the gain from smoothing surfaces before putting them into rubbing contact. But smoothness is not always the only feature involved. There are departures from true geometrical shape of each component.

Running-in then becomes a process of wearing away material over appreciable areas, until the surfaces correspond sufficiently to form a continuous film for all running conditions. The problem is so to choose the materials and running conditions that this wear occurs as a mild process, the rate decreasing asymptotically, and not by severe cohesion resulting in the tearing out of large particles from the surfaces and thus spoiling them. If the wear takes place at a decreasing rate, the fluid film will automatically be established at the appropriate stage, for as the material is removed the local contact pressures will become less and the heat generation less; the hot oil will then be replaced by oil of higher viscosity and thus better load-carrying ability, leading to a thicker film and thus complete separation of the surfaces.

Mechanism of Wear.—The detailed procedure by which wear occurs is very imperfectly known. It was formerly thought that wear occurred because prominences on the two surfaces rubbed each other away. Whilst this probably holds to some extent with very rough surfaces, and while the deformation of a soft surface by roughnesses on a hard one contributes to wear, normal wear is now generally considered to be due basically to molecular cohesion. There is occasional detachment of an atom and, furthermore, the atom oxidizes. In most cases of sliding the detached atoms pass into the body of the lubricant.

[1] Abstract of a Paper by D. CLAYTON, B.Sc. (Engineering Dept., National Physical Laboratory), appearing in the October, 1940, *Journal* of the Inst. Mech. E. [2] Am. Soc. for Testing Materials, Symposium on Wear of Metals, p. 4.

But when wear becomes more severe, particles of larger size than atoms are commonly detached, the strength of the cohesion at the surface contact then exceeding the strength of attachment of the particle to its parent body, probably weakened by fatigue. The range of particle size is relatively large, being associated with the various stages of wear, from the fine kind where the surface remains smooth, through scoring and on to scuffing, in which particles of crystal size or larger are removed through local seizure and the surface presents a torn appearance. Beyond this last stage softening or melting and welding of the metals occurs.

Surface roughness leads to concentration of load on the high points and increased tendency to seizure there. But it has been shown that beyond the first smoothing from the rough-ground condition the improvement is slight for further refinement; possibly the yield of the material then swamps residual fine irregularities. A matt rather than a mirror finish seems to find favour for cylinder bores, the latter being said to result in easier tearing. Is this due to high cohesional forces as a result of more intimate contact or greater area in contact, or else to the lubricant being wiped off such a surface too completely, in spite of the small size of oil molecules compared with the irregularities of even mirror-smooth surfaces? Systematic investigation is obviously needed to see whether there is an optimum smoothness for particular operating conditions.

The external variables, speed, load, etc., have a marked influence on behaviour; wear will go through almost its whole range of types as the load is varied in tests with an extreme-pressure lubricant. An intermediate factor is temperature at the contacts as a consequence of running conditions. This can reach high values when the speed is high—for example, in the case of gear teeth, and with changes in the cast iron of piston rings. This temperature has immense importance under conditions of severe duty in connexion with cohesion between surfaces, the breakdown of the crystalline structure to amorphous layers, and on the behaviour of the lubricant.

Surface fatigue has been shown to be an important factor leading to breakdown of the crystalline structure. Relevant to this is the influence of surface stress from machining processes on rate of wear. The structure of the material would be expected to be significant, and several investigations have pointed to wear being more nearly related with structure than with other properties of the material, such as hardness In the case of piston rings the structure may be an indication of the ease with which particles can be detached, governing their size and physical characteristics; if the particles are large and hard they will cause further damage, whereas if they are small and friable, they will work down to a size smaller than the surface irregularities and so escape easily in the lubricant.

Plastic yield on a small scale as well as on the larger one needed to accommodate lack of alignment, etc., is important in flattening a surface to facilitate the formation of local fluid films and in some cases to initiate a complete film. It is often difficult to distinguish between this behaviour and the influence of cohesional properties. This applies to many cases where practice has demonstrated the advantages of certain pairs of metals. It has been suggested that the efficacy of tin coating of pistons to obviate scuffing lies in the gradual transfer of the tin to the piston ring faces, whereby the soft metal fills in the roughnesses with the same results as plastic flow. On the other hand, a third metal has been found to have a striking influence on the wear of a pair of metals together, for example cast iron and steel rubbing on cast iron. Investigation of the pairing of metals is obviously needed and a factor of importance is the ability of one metal to take up particles of the other. A soft metal taking from a hard one may become a lap for it, increasing the wear greatly. When particles of the soft one adhere to the hard one, the former in effect rubs against itself and rapid failure results.

Oil is usually found to alter the scale of wear enormously, due to the formation of fluid films, but the question of the influence of the oil on rubbing contacts remains. The largest and most oily molecules in lubricants are small (10^{-7} inch) compared with the roughness of even smooth surfaces; the first boundary layer is thus very insignificant in thickness for protection against high load concentrations and the high temperatures reached in rubbing. Tests have shown indeed that essentially the same phenomena occurred in the presence of oil as without, but to a less degree. In some tests lubricants did not prevent frettage corrosion but did defer it. In others the development of rust was prevented by the lubricant.

Mention should be made of the wear on a macro-scale known as pitting or galling, in which particles of relatively large size, flakes of metal, are detached from the surfaces, due to the stress from concentration of the load on high points of the surface, or similar effects from a particle trapped between the contracting surfaces; with repetition of the stress failure occurs by fatigue and the particle is detached. Once a crack has been started it is probable that hydrodynamic pressures in the oil film play an effective part in extending the crack and in ultimately ousting the flake.

Addition agents in the shape of chemical substances are a feature of some modern lubricants. Many substances have been used, but sulphur, chlorine and phosphorus have been the most prominent. Many difficulties have had to be overcome in producing a satisfactory commercial lubricant, but a range of such lubricants can now be obtained which meets varied requirements from mild to severe conditions. These lubricants act by means of chemical

attack at the temperatures reached at the contacts, the activity increasing with elevation of temperature, or decomposition to active constituents taking place in the immediate vicinity of the contact; a layer of iron sulphide, chloride, etc., is considered to be formed, in which relative sliding can occur without the underlying metal cohering or seizing locally. Such a special lubricant can be used, for instance, to run-in gears which subsequently can use plain mineral oil.

The 1940 Queensland Bureau *pH* Meter.

For controlling the Liming of the Juice.

In 1935 the Queensland Sugar Bureau took up the study of the Khainovsky *pH* Meter as used in Java for the instantaneous and continuous control of juice liming, the colorimetric method of indication being

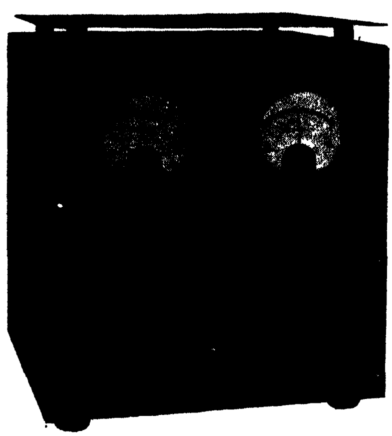


Fig. 1.

recognized to leave much to be desired. They were able to simplify the apparatus, and better adapt it to Queensland conditions.

Now under the name of the "Bureau *pH* Meter" the new design is in satisfactory operation in most of the mills of the Commonwealth.[1] Fig. 1 shows the 1940 model. Experience has proved it to have an ample sensitivity, to be easy to manipulate, to be robust, and to be entirely reliable under tropical factory operating conditions.

Description of the *pH* Meter.

It comprises a Wheatstone bridge type of circuit, two arms of which are fixed resistances, and the other two suitable radio valves. In use the Meter is set to the *pH* required, a zero centre dial indicating the deviation in fractional *pH* units from the *pH* value at which it is desired to maintain the juice. Its sensitivity can be adjusted to $\pm 0{\cdot}1$ *pH*. Direct reading temperature compensation is included, and is calibrated from 20 to 70°C.

Operation is simple, as, having once been "set," only a routine 24-hour check is required. Voltage fluctuations in the supply current do not affect the reliability of its readings. It uses only A.C. Normally built for 240 volts 50 cycles, it can be constructed for other voltages and frequencies. Its power consumption is only 13 watts. It measures 10 × 9 × 9 inches.

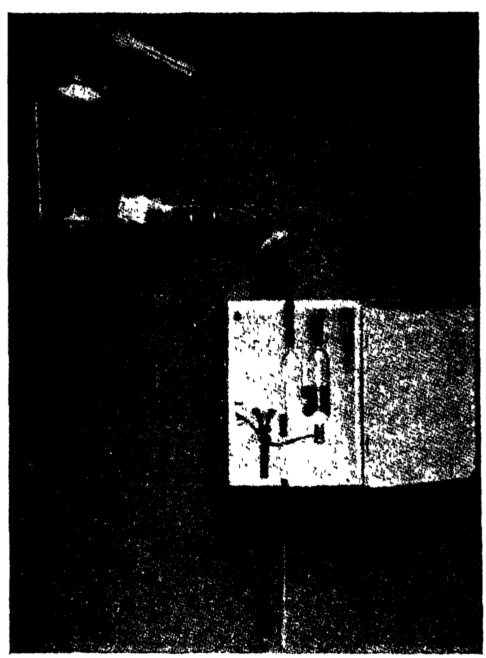


Fig. 2.

Complete Equipment Required.

The complete equipment for the control of juice liming in the sugar mill, liquors in the refinery, or the like, consists of the following parts: (1) The Bureau *pH* Meter (Fig. 1) as described above; (2) the saturated calomel and antimony electrode assembly (Fig. 2); and (3) the flow chamber (Fig. 3).

1 Outside Australia, it is sold by the Sugar Manufacturers' Supply Co., Ltd., London.

Units (2) and (3) of this equipment will now be described.

The Electrode Assembly.—This has been specially designed for general sugar-house purposes. The calomel cell consists of a glass bulb with a platinum electrode and terminal, and is provided with an arm connected to an aspirator bottle containing the necessary saturated potassium chloride solution. This arm is also joined to a vertical glass tube, drawn out to a point, and provided with a glass plug, which is simply pressed up for a few seconds in order to flush out the tube. The antimony electrode seen on the left consists simply of a pellet of the metal mounted on an electrode rod provided with a terminal.

It being very desirable that the calomel antimony unit is adequately protected from dust and mechanical injury, a small case is provided to contain it. As may be seen, the calomel cell is firmly supported inside the case by means of a spring clip; its terminal is connected to one of the terminals on the side of the case, while the antimony electrode, suspended from a copper strip on the side of the case, is attached directly to the other terminal. These two terminals on the side of the case are connected up by leads to the *pH* Meter.

The Flow Chamber.—In using the equipment, the plugged tube of the calomel cell and the antimony electrode are immersed in the juice, liquor, water or other liquid under examination, which should be made to pass through a suitable flow chamber. Any arrangement whereby the liquid is made to flow smoothly past the electrodes will suffice, Fig. 3 showing a satisfactory type. It consists simply of a *U*-tube constructed of 2 in. piping and standard fittings. It is made at the site, as it does not form part of the *pH* Meter equipment as supplied by the manufacturers.

Any other type of flow chamber may be used, e.g., a simple trough, provided always that: (*a*) the sample be continuously supplied; (*b*) the velocity of the liquid under examination be constant and at least 2 in. per sec.; (*c*) there is no appreciable time lag; (*d*) it is self-cleaning; and (*e*) the electrodes are easily accessible when immersed.

It must be emphasized that the time lag between the point at which the lime is added, and that at which the *pH* is being measured be as small as possible. Hence the flow chamber must be situated so that the sample is most conveniently obtained. Naturally, the *pH* Meter must be placed in such a position that its indicator can easily be seen by the operator when making adjustments to the lime distributor.

This essential condition having been fulfilled, the operator can observe the effect of any alteration to the lime addition at once, and it follows that a far better control can thus be obtained than with the usual system. It has been found that foremen soon become accustomed to the operation of the instrument, and in fact declare themselves unable to lime juice properly without its use.

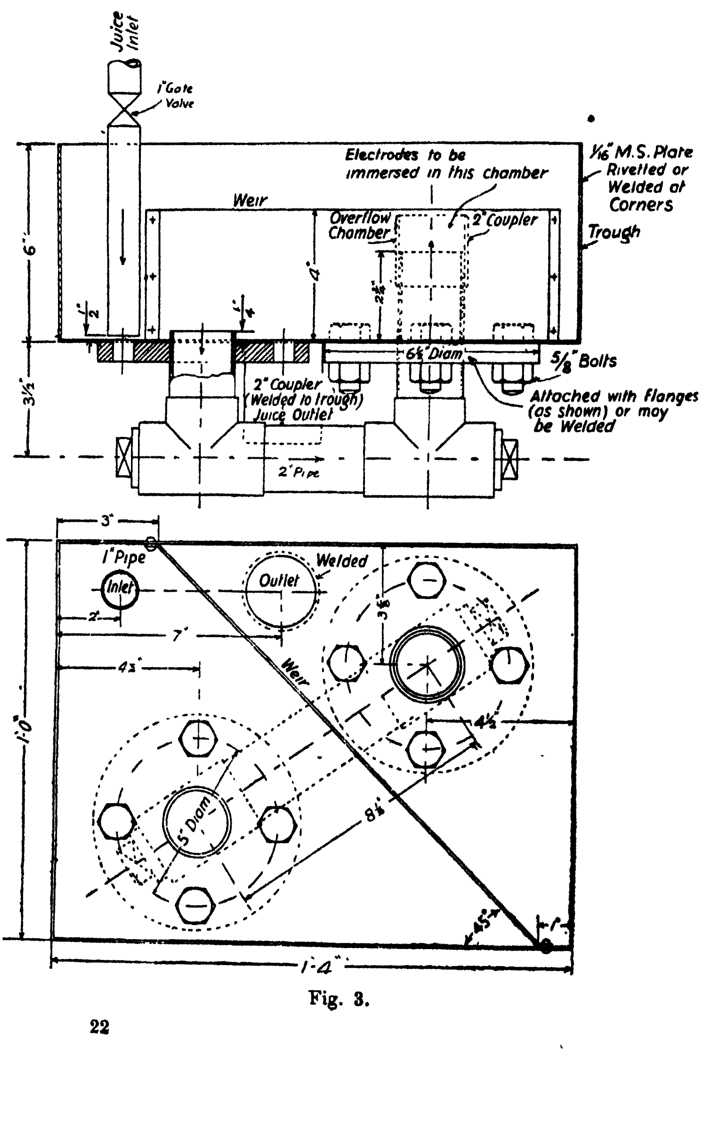


Fig. 3.

The Advantages of Spacing Beet.

Several references have been made to the drill recently invented by Dr. H. Martin Leake for spacing beet[1] and to the advantages to be derived from spacing. The obvious advantages are : saving of seed, since it is necessary to sow only 4 to 5 lbs. instead of the usual 12 to 15 lbs. ; and saving of labour in singling the relatively thinly scattered and spaced seedlings. A less obvious advantage, and a somewhat unexpected one, is the increased weight of crop which may result. Examples of this were given in the quoted reference, and the explanation there offered was that, under the conditions of spacing, the individual seedlings were less crowded and, consequently, less subject to check before singling. Further, for the same reason, the retained plant was rarely checked by the process of singling and, for both reasons, was enabled to send its root down deeply and, in consequence, in a position to withstand a drought better than a plant which had been checked in the seedling stage.

We learn that the results obtained with the latest model of this drill during the past crop season confirm these conclusions. The season was particularly dry. After adequate rains in the spring for the preparation of a favourable seed-bed, little rain fell throughout the season, and only one fall of any real agricultural value occurred about mid crop. Some 130 acres of commercial sowings were drilled with this model in the Eastern Counties of England and, in one 20-acre field, both it and a cup drill were used, thus giving a dividing line. At harvest this line stood out clearly, the spaced area being obviously the heavier crop. Along the dividing line four blocks were chosen, each 10 yards in length and embracing 6 lines each of the spaced and ordinary crop. These eight blocks (four spaced and four ordinary) were lifted separately and the results are tabulated herewith. They comprise an analysis of four runs, each of 10 yards, along the dividing line between the two drills; six lines lifted on each side. Comment is hardly necessary but attention may be directed to the larger number of secondary roots in the ordinary crop, an indication of the relative ease with which the spaced crop can be singled. Most of these secondary roots are so small that, in commercial practice, they would be discarded by the singler and not appear in the produce shipped to the factory. For this reason, the double calculation of yield, one based on the total crop and the other on the primary roots only, is given.

Another point of interest which arises out of these results is the low stand in both crops. For reasons as yet unexplained, there has been this year an excessive amount of delayed germination, much of the crop still coming through when the first plants to germinate were ready for singling. The reason for this is not obvious, though several explanations

	Spaced.	Ordinary.
Roots over 6 lbs.	1	0
Roots 5 to 6 lbs.		
Combined figures for the 4 runs	5	0
Roots 4 to 5 lbs		
Combined figures	22	2
Roots 3 to 4 lbs.		
Combined figures	71	17
Roots 2 to 3 lbs.		
Combined figures	151	71
Total roots (i.e. groups)		
(1)	121	137
(2)	123	155
(3)	124	151
(4)	124	135
Total	492	578
Roots, secondaries, etc.		
(1)	23	98
(2)	30	82
(3)	31	98
(4)	46	96
Total	130	374
Weight of roots (primaries)		
(1)	223 lbs.	166 lbs.
(2)	242 lbs.	171 lbs.
(3)	293 lbs.	224 lbs.
(4)	251 lbs.	156 lbs.
Total	1010 lbs.	717 lbs.
Weight of roots (secondaries, etc.)		
(1)	9¾ lbs.	30 lbs.
(2)	11¾ lbs.	21 lbs.
(3)	13 lbs.	30 lbs.
(4)	15 lbs.	21 lbs.
Total	48¾ lbs.	102 lbs.
Weight of roots (primaries and secondaries)		
(1)	232 lbs.	197 lbs.
(2)	254 lbs.	192 lbs.
(3)	307 lbs.	254 lbs.
(4)	266 lbs.	176 lbs.
Total	1059 lbs.	819 lbs.
Average weight of roots		
(1)	30·7 oz.	23·0 oz.
(2)	33·0 oz.	19·7 oz.
(3)	39·6 oz.	26·9 oz.
(4)	34·4 oz.	20·9 oz.
Combined	34·4 oz.	22·7 oz.
Percentage increase of spaced roots		
(1)	33	—
(2)	67	—
(3)	47	—
(4)	64	—
Combined	52	—
Stand (per cent.)		
(1)	55·5	57·0
(2)	56·0	64·5
(3)	57·3	60·0
(4)	57·3	56·2
Combined	56·5	59·4
Percentage increase of crop		
(1)	18·0	—
(2)	32·0	—
(3)	21·0	—
(4)	51·0	—
Combined	29·3	—
Yield per acre (tons), combined figures		
Total crop	16·4	12·6
Primaries only	15·6	11·0

[1] *I.S.J.*, 1938, p. 60.

suggest themselves. This aspect is under investigation, for the adverse effect is naturally greater in a spaced crop than in an ordinary one.

Evidence of the saving incurred in singling comes from another farm on which the whole beet area, some 45 acres, was drilled with the spacing drill. Singling was here effected on contract, and the rate paid was 35s. per acre, as compared with the 56s. or 58s. paid on neighbouring farms for crops drilled with an ordinary drill.

Beet Factory Technical Notes.

Toppenish Factory, Yakima (Wash.). *Facts about Sugar*, 1940, **35,** No. 8, pp. 22-25.

Results from the 1939 operations of the Utah-Idaho Sugar Co. in the Yakima (Wash.) valley were a great success, after the initial failure to found the beet sugar industry in this district leading back to 1917. In that year 6,000 acres of beet were planted in this highly fertile valley, and a factory built at Yakima to process the harvest. Later, prospects appearing to be so favourable, factories at Sunnyside and Toppenish were also erected.

But in 1918-19 the white fly scourged the territory with the dreaded curly-top disease, with the result that less than half the planted acres were harvested and neither of the new factories operated that year. Ultimately, in 1925, beet cultivation in that territory had to be abandoned and all three factories had to be dismantled.

In 1923, an extremely bad year, J. W. Timpson, district manager for the Company in the State of Washington, observed that in some fields where the beets were apparently subjected to the same severe curly top infestation as elsewhere, a few healthy plants had survived During the next few years the Bureau of Plant Industry of the U.S. Department of Agriculture carried out extensive breeding trials with these survivors, which resulted in a resistant variety being released with extremely successful results in the Yakima area.

In 1936 the large-scale plantings made resulted in an average yield of 18 tons per acre, with no sign of the dreaded curly top disease In the fall of that year arrangements were made to erect a modern factory to process the beets, thus again reviving the industry in the State of Washington. It was built on the same site as that from which the old Toppenish had been removed 12 years previously.

It is a completely electric factory with a self-contained turbo-generator furnishing the required energy. Exhaust from the turbine is carried at 35 lbs. pressure, and passes to the steam chest of the vertical single-pass first effect evaporator, the remaining four bodies of which have horizontal tubes. High and low raw pans are boiled with first and second vapours, and the juice and diffusion battery heaters are fed with first, second and third vapours.

An air-lift raises the beets into the factory, the principal advantage of which is that the flume water is raised with the beets to an elevation such that a gravity sewer may be used for its elimination. The washing effect of the air-lift is such that the beet washer is seldom used. Following this, the roots go through the cutters and diffusion battery, both of which are of the conventional type

Dorr continuous carbonatation with thickener are used with Eimco vacuum filters handling the sludge. Conventional type crystallizers equipped with Dyer-Blanchard cooling units effectively handle the low raw massecuite. The centrifugals are belt-driven Roberts high-speed machines with 40 in. × 24 in. baskets. In 1939, Toppenish produced 650,000 bags of white sugar, or very nearly the same amount that was produced by the three factories during the first unfortunate eight campaigns in the Yakima valley.

De-Liming Beet Second Carbonatation Juices. W. Reischauer. *Centr. Zuckerind.*, 1939, **47,** pp. 1110-1111.—This is a continuation of the work done on de-liming 2nd carbonatation juices by violently agitating them so as to decompose the bicarbonate, liberate CO_2 and precipitate $CaCO_3$ It was first proposed by the Institute for the Sugar Industry in Berlin,[1] where, in a small-scale plant, a high-speed propellor was used but found inadequate in large scale practice. In the author's factory the carbonatation tanks are equipped with fine spray nozzles, through which a great volume of air is blown into the hot juice. There are no movable mechanical parts; and no trouble has been experienced by excessive foaming. Air at about 40°C. is used, and the loss of heat from the juice is small. First carbonatated juice enters the second tank at about 96°C. and leaves it at about 88°C., at which temperature filtration can be carried out satisfactorily. In this way juice which contains no incrustating impurities is obtained for the evaporators.

1 *I.S.J.*, 1938, pp. 238, 362.

Use of Cellulose Pulp in Filtration. K. SANDERA and A. MIRCEV. *Listy Cukrovarnické*, 1940, **58,** p. 61.—Bleached or unbleached paper pulp suspended in water can be used for the precoating of filter cloths, kieselguhr and activated carbon being added at the same time. It makes little difference to the rate of flow whether the pulp pre-coat is formed first, or whether it is mixed with the carbon and the two used together. By the use of paper pulp a brilliant filtrate is soon obtained, as the small interstices in the cloth are filled up almost at once No difference could be observed between the effects of bleached or unbleached pulp, and the latter being the cheaper it would naturally be given the preference.

Formation of False Grain in Massecuites. H CLAASSEN. *Deut. Zuckerind*, 1939, **64,** pp. 1013-1014.—False grain will not form when a syrup of high purity seeded with sugar dust is boiled down, because, favoured by the vigorous circulation, the existing grain has every opportunity to grow to a size which can be handled in the centrifugal machines without difficulty. It is only when the syrup has become exhausted or partly exhausted, when its purity has fallen to a low value, when it has become rather viscous, and when it has become too supersaturated, that false grain will appear. When false grain has formed under such circumstances, it is impossible for it to grow to a suitable size to be handled in the centrifugals, the syrup having become viscous and the massecuite circulation too greatly impeded. If suspended solids are present in the syrup, i.e., if it has not been properly filtered previous to taking it into the vacuum pan, a further formation of false grain may occur, these particles acting as grain nuclei, which aggravate the trouble. Such conditions occur especially in the cane sugar industry, in which, in the manufacture of raw sugar, clarification is often incomplete, and an amount of suspended solids may be present. In conclusion the author remarks that the formation of false grain is generally to be traced, not so much to the actual pan boiling process, but rather to the fact that the juice has been insufficiently purified.

Determination of the Rate of Solution of Poured Refinery Products (II to IV). R. FLEISCHMANN *Zeitsch. Zuckerind. Czechoslov.*, 1939, **63,** pp. 266-270.—In a lengthy series of laboratory experiments, the author showed that poured refinery products had a higher rate of solution in water than those which had been made by pressing, the figures supporting this being the average results of five different methods of determining the rate of solution. Applying the so-called "floating method" of determining the rate of solution, it was found that the effect of drying poured refinery products for 1 hour at 102 to 104°C. was to diminish the rate, but that after a prolonged period of heating the rate remained constant. Exposure of poured refinery products to air of 50 per cent. relative humidity exerted little effect on the inner structure of cubes, but a longer storage under these conditions prolonged the time of solution. Poured refinery cubes after being dried for 1 to 3 hours at 102 to 104°C. were exposed to atmospheres of 30 to 50 per cent relative humidity at temperatures from 15 to 20°C and examined for their rates of solution in water at 5-day intervals, using five different methods of so doing. In sum, the results obtained showed that when the effects of moisture and of temperature are eliminated, the rate of solution does not change as the result of exposure under the conditions indicated.

Micro-Method for the Determination of Harmful Nitrogen. A. JANKE. J. HOLOTA and E. MIKSCHIK. *Zeitsch. Wirtsch. Zuckerind.*, 1939, **89,** pp. 516-525.—At the present time there are two micro-methods for determining the harmful nitrogen in beet factory products, the Riehm and the Stanek and Pavlas [1] These two methods are now converted by the authors into micro-methods, for which only about 0·25 ml. of juice is necessary, and concordant results are obtained. Not counting those operations, as centrifuging, filtering, etc., which can be attended to by assistants, a determination takes only about 10 minutes of the chemist's time, making it possible to test 50 beets in one day. Some of the author's results obtained show that the concentration of the harmful nitrogen is greatest in the crown, decreasing gradually until the tail is reached.

The Control of the Formation of Sugar Crystals by means of Electrical Conductivity Measurements. K. SANDERA and A MIRCEV. *Listy Cukrovar.*, **58,** pp. 41-44; through *Chem. Abs.*, 1940, **34,** 6841.—When the electrical conductivity of the liquor was measured at a falling temperature it remained approximately constant. When the samples were brought to a constant temperature, the conductivity rose from 100 to 208 per cent. of the original value in 24 hours, and attained a value of 370 per cent. on the fourth day. For comparisons, measurements were made at 20, 45, 60 and 70°C. In both seasons the conductivity approached the absolute value 125 to 135 $\times 10^{-6}$ ohms in all liquors just before they were sent to the centrifuges. Conductivity determinations can be used for controlling additions of water to the liquors and may supplant the more laborious determinations used for controlling the crystallization of sugar.

[1] *I.S.J.*, 1935, pp. 114, 403.

Chemical Reports and Laboratory Methods.

Notes on Sampling and Analyses of Feed and Boiler Waters and on Combustion Control. F. W. HAYES. *Proc. 14th Congr. South African Sugar Tech. Assoc.*, 1940, pp. 114-124.

Analysis of Feed and Boiler Waters.

Discussing the determination of the hydrogen ion concentration, it is said that it is recognized that colorimetric methods are subject to many errors due to substances interfering with the colour change, and that in unbuffered solutions (as fairly pure condensates) results may be misleading. But electrometric methods have been developed which give exceedingly accurate results, and of these, those using the glass electrode are the most satisfactory.

Conductivity measurements are valuable. Having, e.g., by analysis, the total solids and conductivity of a water of given composition at a sufficient number of different concentrations, the solids may afterwards be determined with fair accuracy by conductivity measurements alone. Tests of this nature should be done once or twice per 8-hour shift on each boiler. Conductivity measurements are also of value in determining the purity of condensate and other distilled waters.

In sampling boiler waters, it is futile to work on haphazard samples drawn from the gauge glass cock into an open container without cooling. It is necessary not only to cool the sample to atmospheric temperature before drawing-off, but also to filter it as well as possible at boiler temperature and pressure. In the determination of the hydroxide and carbonate, it has been shown that errors can arise in the ordinary phenolphthalein-methyl-orange titration; but the carbonate may be found by an evolution method, in which the CO_2 is liberated by an excess of acid and heating, and carried by an air stream into an excess of standard barium hydroxide, which is then titrated with standard acid. In determining sulphate the tetrahydroxyquinone volumetric method has been found quite satisfactory,[1] provided that silicate, magnesium and carbonate ions are not present in too high a concentration.

Combustion Control.

With flue gases a continuous record of the CO_2 at least is highly desirable, but if intermittent analysis only is possible, one must make sure that the sample is collected over a fairly lengthy period. Determinations must be made of CO as well as of CO_2, and it is possible at times for hydrogen to appear in the flue gases. Therefore, all laboratories should possess a full Orsat equipment, including a slow combustion pipette. Of CO_2 recorders, two instruments are recommended, the "Electroflo" absorption meter and the "Multilec" Mark I, the latter being a really outstanding instrument with an accuracy found by careful Orsat checks very close to 0·1 per cent.

If combustion is incomplete, CO, hydrocarbons and possibly H will be present, and theoretically O should be absent. This is where speed of the gases and furnace temperature play an important part. In passing through the fuel, the O is combined with the carbon to form CO, and it is just above the fuel bed that the final conversion to CO_2 takes place; hence the necessity for secondary air.

Now if the speed of the gases is too great, the CO may be rushed through this zone before oxidation is completed, so that it is still possible to have a large excess of air with incomplete combustion, which possibility dwindles as temperatures rise, more particularly when preheated air is used. Mixing of the gases must be good, but sufficient time for combustion must also be given.

High CO_2 does not necessarily mean perfect combustion, as 1 per cent. of CO means 4·5 per cent. loss due to incomplete combustion. A low CO_2 content may be caused by insufficient air (with high CO), but this is almost invariably due to an excess of air. A great deal of this excess of air (according to COETZEE about 60 per cent.) may come through leaky settings.

One should not try to get a high CO_2 simply by cutting down the draught. A proper relation of draught, fuel and fuel resistance is required, and it should be borne in mind that the CO_2 indicates roughly the percentage of air used to the percentage of air that has not been used. Losses of heat through excess air above 12 per cent. CO_2 are not great, but below this figure the fall in efficiency is considerable. On the other hand, when the CO_2 rises to 14 per cent. or more, tests should certainly be made to see if any CO is present.

Extraction of Potash from Bagasse Boiler Ash. P. J. POLDERMANS. *Archief*, 1940, **1**, pp. 123-125.

It seemed to be worth while investigating whether the K_2O could be extracted from bagasse boiler ash in an easy manner, so as thus to obtain a by-product of commercial value. Here are given the analyses of bagasse boiler ashes obtained from sugar factories in Java, and also in the Philippines, showing that about 5 per cent. of K_2O may be present, but in combination with other constituents, the principal of which is SiO_2:

	Java.	Philippines.
Silica (SiO_2)	64·0 to 83·0	75·0 to 85·0
Iron and alumina	4·0 to 17·0	4·0 to 8·0
Calcium oxide (CaO)	1·5 to 4·5	2·0 to 3·0
Magnesium oxide (MgO)	1·9 to 3·6	1·5 to 3·0
Potassium oxide (K_2O) ..	2·0 to 5·0	4·0 to 7·0
Phosphoric acid (P_2O_5) ..	2·0 to 3·0	2·0 to 4·0

1 *I.S.J.*, 1937, p. 24.

It is clear therefore from these figures that the ash must consist principally of complex silicates, and that most of the potash will be present as a difficultly-soluble glass, only a small amount being in the form of potassium phosphate. Of course, a greater amount of potash would be dissolved out by HCl, but then it would take up a relatively large amount of impurities at the same time.

These deductions were put to the test in the laboratory by some experiments made with bagasse boiler ash collected from two factories in Java; 100 grms. of each sample were treated for 2 hours with boiling water, filtered, and the K_2O determined in the filtrates. An extraction was also made with cold water, and one with dilute hydrochloric acid, the results (as a percentage of the dry ash) being as follows:—

	K_2O per cent. on the Dry Ash. Padokan	Soedhono.
Using boiling water during 6 hours..	0·30	0·80
Using cold water during 1½ hours ..	0·18	—
Using hydrochloric acid (1 : 1)	2·90	2·50
Unburnt carbon in the ash	3·10	0·50
Moisture content................	0·20	0·20

It is seen, therefore, that out of a possible 5 per cent. of K_2O originally present, only 0·3 to 0·8 per cent. can be extracted with hot water. As much as 2·9 per cent. K_2O could be extracted with dilute HCl, but this operation could not be regarded as one capable of being applied commercially at the sugar factory.

If one were to calculate up the total amount of potash which could be extracted with hot water from bagasse boiler ash in all the factories of Java, the total amount would be a comparatively small one, and hardly worth the cost of recovery. It could not possibly be regarded as a practical proposition.

It is pointed out by the author that the case is quite different in the case of molasses ash, which contains about 40 per cent. of K_2O. Practically all of this potash is completely soluble in water. If the molasses were burnt under the boilers, it would be necessary to carry out the combustion in a separate oven, so as to avoid contamination of the ash by the bagasse silicates. Working under these conditions, it should be possible remuneratively to extract the potash from molasses, and possibly find a fair market for it in its crude form.

C.C.S. Formula in Relation to Factory Control. E. R. BEHNE.[1] *Proc. Queensland Soc. Sugar Cane Tech. 11th Conf.*, 1940, pp. 225-237.

It is a theoretical yield formula expressing the "Commercial Cane Sugar" and was defined by N. M. THOMAS as: "Such portion of sucrose or cane sugar contained in a certain quantity of cane as would be obtained in the form of pure white sugar of 100 net titre if milling and refining recovery could be raised to a prescribed imaginary standard of very high efficiency." It equals:

$$\text{Pol. in cane} - \frac{\text{Impurities in Cane}}{2}$$

the impurities in cane being = Brix — pol. as found from the following:

$$\text{Brix in cane} = \text{Brix in F.E.J.} \times \frac{100 - (3 + \text{fibre})}{100};$$

$$\text{and Pol. in cane} = \text{Pol. in F.E.J.} \times \frac{100 - (5 + \text{fibre})}{100}$$

where F.E.J. is first expressed juice. Then the tons of 94 n.t. sugar made × 100 tons C.C.S. in cane gives the coefficient of work (c. of w.) as used in the Queensland factories as a control figure.

It was devised in 1888 by Dr. KOTTMANN, of the C.S.R. Co. of Sydney, as an attempt to find a standard basis of comparison taking into consideration the quality of the cane as well as the sugar content, and was based on the following assumptions: (1) one-fourth of the soluble impurities in the cane are removed by clarification, leaving three-fourths to form molasses; the molasses is exhausted to a true purity of 40; and there is no loss of sucrose in manufacture other than that retained in the final molasses.

It is in general use throughout the Queensland factories, as the basis of the present system of chemical control, and also of practically all schemes of cane payments. It is the only means used for calculating the sugar introduced into the mill. It is, however, far from satisfactory as a formula for such a purpose, as has been pointed out by various writers. It contains three possible sources of error: (1) apparent values are always used instead of true ones; (2) the value of the "3" and "5" figures are doubtful; and (3) the fibre is a difficult constituent to determine.

In regard to (1) it is here pointed out that the use of apparent values gives C.C.S. values which in general are too low and c. of w. values that are too high. In regard to (2), discrepancies are introduced by these factors, which are intended to express the actual relationship between the composition of the juice analyses and that of the original cane, the true factors varying from year to year, and to such an extent as to introduce a serious error. In regard to (3), as KERR has emphasized,[2] the difficulty in making an accurate fibre determination lies not only in the analytical procedure, but in the fact that the presence of trash in varying amounts renders correct sampling well nigh an impossible task.

Of the items dealt with above, most of them may be grouped together under the general heading of "Seasonal Influences" which is one of the reasons which has long been put forward by mill chemists

[1] Bureau of Sugar Experiment Stations, Brisbane.

[2] *I.S.J.*, 1938, p. 180; 1939, p. 227.

for the explanation of low c. of w. values. That this opinion has been soundly based in most cases is shown by the following figures expressing the c. of w. as determined by the C.C.S. formula and actual weighing and sucrose determination :—

	C.C.S.	Weighing and Sucrose
1936	101·24	99·02
1937	98·38	98·57
1938	95·37	98·24
Average	98·33	98·61

showing that the C.C.S. value varied over a wide range while the figure given by actual weighing and sucrose determination changed but little from year to year. Other factors affecting the value of the C.C.S. formula are : (1) the uncertainty of the composition of the first expressed juice, which depends on the pressure by the rollers and the degree of preparation of the cane ; and (2) the condition of the cane, that is, the quantity of adhering trash, both of which introduce varying errors. Concluding, the author says : "As an empyrical formula, it (the C.C.S. formula) is susceptible to various in conditions, and for factory control is by no means satisfactory."

Fermentation of Glucose to Gluconic Acid. A. J. MOYER, E. J. EMBERGER and J. J. STUBBS. *Ind. & Eng. Chem.*, 1940, **32**, pp. 1379-1383.—Heretofore it has been impossible to ferment concentrated solutions ; but now, by the addition of boric acid or borax and an excess of calcium carbonate, the gluconic acid formed is continuously neutralized, and it is possible to work with 25 per cent. solutions, using either *Aspergillus niger* or certain bacteria.

Recent Advances in Water Purification. M. C. SCHWARZ. *Proceedings of the Louisiana Sugar Manufacturers' Association, 2nd Annual Meeting.*—Recently a new type of base-exchange material has been developed, a carbonaceous zeolite. It is made from coal by treatment with sulphuric acid, is resistant to water of low *pH*, and removes ferrous iron. It has about double the base-exchange capacity and flow rate of ordinary zeolite, is inexpensive, and may easily be regenerated by sulphuric acid or by salt. When the former chemical is used, this base-exchange material decomposes all bicarbonates, retaining the lime, magnesia and sodium, and leaving the CO_2 behind. Other points from the paper are that the residual lime and magnesia left after the softening of water by the lime-and-soda process can be separated by causing the treated water to percolate through a bed of the precipitated sediment. And that a new base-exchange resin has been found to be capable of removing Cl and SO_4 as well as Ca and Mg from hard waters, the treated waters have the purity almost of distilled water. It is regenerated by alkali.

Removal of Silica from Water. L. D. BETZ, C. A. NOLL and J. J. MAGUIRE. *Ind. & Eng. Chem.*, 1940, **32**, pp. 1320-1329.—Freshly precipitated aluminium hydroxide can remove soluble silica from water, the most effective *pH* range for practical use being 7·6 to 8·0. Its efficiency is greatest at low temperatures, and a retention of one hour suffices. At 95°C. magnesium oxide will reduce crystalloid or soluble silica practically to zero, but "various types" of the oxide behave differently in the amount removed per part of MgO. A period of 15 min. is sufficient, and a *pH* of 10 appears to be an optimum for the reaction.

Applied Microbiological Studies on the Manufacture of Cane Sugar. XVI. Roles of Micro-Organisms. 2. MASASI ADATI. *J. Soc. Trop. Agr., Taihoku Imp. Univ.*, **11**, pp. 180-192 ; through *Chem. Abs.*, 1940, **34**, 6471.—The physiological and morphological properties of micro-organisms isolated from the cane stem are described. Most of them hydrolyse sucrose.

Solubility of Gypsum in Concentrated Sugar Solutions in the Presence of Inorganic and Organic Salts. TAKEO YAMANE, MAMORU YUGE and ISAMU KAMIHIGOSI. *J. Soc. Trop. Agr., Taihoku Imp. Univ.*, **11**, pp. 87-94 ; through *Chem. Abs.*, 1940, **34**, 6471.—Potassium aconitate markedly increased the solubility of $CaSO_4$, which, in a 50 per cent. sucrose solution at 80° was 0·037 per cent., while in refined syrup it was 0·129 per cent. Elevation of the temperature and concentration of the sugar solution decreased the solubility of $CaSO_4$.

Clarification in Plantation White Sugar Manufacture. VII. Prevention of Coloration during the Carbonatation Process. EIZIRO HAMAGUTI, TOSIHIDE SIMIZU and TERUO TANAKA. *J. Soc. Trop. Agr., Taihoku Imp. Univ.*, **11**, pp. 174-179 ; through *Chem. Abs.*, 1940, **34**, 6471.—Coloration during the carbonatation process was prevented by preliminary treatment with SO_2. When metallic Zn was added before or after the SO_2 treatment, a good decolorization was obtained. When the solution was treated with SO_2 neutralized and then heated at 90°C. coloration produced by the carbonatation was faint. Carbonatation in a current of H gave a light-colour juice.

Crystallization of Acidified Mother-liquor of the Second (Sugar) Product. B. E. KRASILSHCHIKOV, M. M. GOLDBERG and M. I. SHOIKHET. *Colloid J.* (U.S.S.R.), **5**, No. 5, pp. 379-388 ; *Khim. Referat. Zhur.*, 1939, No. 9, p. 118 ; through *Chem. Abs.*, 1940, **34**, 6472.—By the action of H_2SO_4 on the second molasses the colloids are coagulated and the salts of organic acids are decomposed. The treatment must be carried out at a temperature of 40 to 50°C. which is gradually lowered, using 2 per cent. H_2SO_4 on the weight of molasses. Under these conditions there is little possibility of inversion of sugar, and the yield is increased.

New Books and Bulletins.

Methods of Analysis of the A.O.A.C. Compiled by the Committee on Editing. Fifth Edition. (Association of Official Agricultural Chemists, P.O. Box 540, Washington, D.C., U.S.A.). 1940. Price : $5·00.

The "Book of Methods" of the A.O.A.C. can very well be described as the most carefully compiled work in the literature of analytical chemistry. As has been explained when noticing previous editions,[1] it is the outcome of the most rigorous scrutiny of procedure by bodies of specialists, each working in their separate sections under their "Referee." Even a "tentative method" is adopted only after having undergone a critical study, while to become "official" it must be submitted to a yet more prolonged examination before its final approval. Descriptions of procedure are carefully edited and re-edited, and allow of no ambiguity of detail in describing determinations.

Its range is quite considerable, being no longer confined to agricultural work. Food products predominate, though some commercial materials, as paints and varnishes, leathers and tanning extracts, are now included. Chemists in our industry will consult with especial advantage the section on "Sugars and Sugar Products" which contains the most precise information on well approved methods of analysing sugars, syrups and molasses, confectionery, honey, commercial glucose, etc. A micromethod (tentative) is given for the determination of reducing sugars. We repeat our remark made when noticing the last edition of this book that great credit is certainly due to those many American chemists who have so thoroughly assisted in the evolution of such a collection of analytical methods.

The Microscope. R. M. Allen. (Chapman & Hall, Ltd., London). 1940. Price : 15s.

This up-to-date guide to the use of the modern microscope is based on the contributions mainly of American designers and manufacturers, and contains a great amount of varied information, most of it of a distinctly practical nature, which can hardly fail to be of use to most microscopists. After an historical introduction, and a chapter on "Optical Principles" it presents an excellent description of modern instruments from the humble students' microscope to the most recent form of reversed research design, which has the supporting arm away from the observer instead of being between him and the tube.[2] On the latter type the opinion is expressed that, while there is much to commend it and the like from both mechanical and operating standpoints, it is questionable whether such will ever supplant the older conventional form.

A chapter on the "Testing of Objectives" gives useful instruction on the measurements of apertures, and the use of diatoms and insect scales as test objects. "Getting the most out of the Microscope" deals with the best general working conditions, and on technique for special purposes, on drawing, projection and micro-photography. Lastly, there is a chapter on the preparation and mounting of material for examination, which also is to be commended by reason of its practical nature.

Altogether the book is a very useful one, and a welcome contribution to this branch of the subject. A criticism to be made of it is that designs of British manufacturers are hardly mentioned. It follows, therefore, that so far as the descriptions of instruments and accessories are concerned a good deal of importance remains unmentioned in the text which should rightly have been included.

King Cane : The Story of Sugar in Hawaii. By John W. Vandercook. (New York and London, Harper Bros.). 1939. Price : $2·50.

This is a chatty account of the growth of the Hawaiian sugar industry by an American traveller who has a gift as a weaver of tales about exotic lands. Written for the ordinary reader of travel books, it will be found of interest, nevertheless, for those sugar men who desire an insight into the history and development of the Hawaiian Islands. In this respect, the earlier chapters, giving a sketch of the racial and economic origins and the growth of industry in what were originally typical Pacific islands, will be found of interest ; the description of the modern equipment of the sugar industry is necessarily sketchy and non-technical. The chapters include such objects of economic interest as Man-power, Life on the Sugar Plantations, Ownership, and Legislation. In one chapter the history of the founding of the now well-known merchant trading houses of Honolulu, such as Castle & Cook and Theo. H. Davies & Co. Ltd., will be read with interest. There are some 15 plate illustrations from photos presumably taken by the author, but too many of them are artistic rather than informative. From an historical point of view, the most interesting is perhaps that showing an ancient stone two-roller vertical mill driven by animal power, a museum piece of the Hawaiian sugar industry.

British Beet Crop Yields.—The long dry spell during last summer tended to restrict root development in the English beet fields, but yields of 20 per cent. sugar or even more have been common. During the first month of the slicing season the average at one Lincolnshire factory was approximately 19¼ per cent. Yield per acre is also expected to be above the average.

1 *I.S.J.*, 1923, p. 210 ; 1925, p. 496 ; 1932, p 160 ; 1937, p. 114

2 As in a previously described design. See *I.S.J.*, 1934, p. 41.

Sugar-House Practice.

Alcohol Manufacture from Blackstrap: Profit and Cost Figures. William L. Owen. *Facts about Sugar*, 1940, **35**, No. 7, pp. 38-41.

In determining the profits from molasses distilleries the most important factor is the price at which the raw material can be obtained. Fermentation efficiencies are secondary. A table is here given (illustrated by graphs) showing, e.g., that, with molasses at 3 cents per gallon as compared with it at 4 cents, it will require an efficiency between 90 and 95 per cent. at the higher price level to realise the same profit as is obtainable at an 83 per cent. efficiency from the cheaper molasses. At a 5 cent level the profit does not represent an equivalent value, even when 95 per cent. efficiency is reached. This estimation avoids the consideration of income from the sale of by-products, which, anyway, is a limited field, as relatively few plants are advantageously situated with reference to potential markets.

In future, however, much importance must be attached to recent improvements in the art of fermentation, in particular the use of the Boinot process, in which an amount of yeast is used for each fermenter which is presumed to be adequate completely to ferment the sugars in the mash without any material increase in the cell concentration during fermentation.[1] Applying this process, it is claimed that efficiencies equivalent to 100 per cent. on the Pasteur equation are consistently attained. Comparable results appear to be obtained by the Hindebrandt process[2]; while the author obtains equally satisfactory results by recovering the fermentation sludges to subject the yeasts therein to a special process (patents pending) which, though inhibiting their development, leaves practically all their enzyme potency intact.

In discussing costs of the production of alcohol by fermentation, it is pointed out that variations of over 100 per cent. are to be found. Referring to the estimated figures by Jacobs and Newton,[3] there is a variation from a low of 3·5 to a high of 7·5 with a raw material cost from 11·50 to 13·50 cents, blackstrap being at 5 cents per gallon. Recent figures for a molasses plant using latest automatic equipment to save labour are, in cents per gallon: Labour, 0·64; steam 0·98; current, 0·042; water, 0·064; supplies, 0·075; laboratory, 0·107; chemicals, 0·026; a subtotal of 1·934; supervision, 0·50; interest (6 per cent. on $250,000), 0·45; depreciation (same) 0·45; taxes and insurance, 0·35; subtotal, 1·75; or a grand total of 3·684. Even such a low figure is eclipsed when the molasses is fermented at the sugar factory, when figures for South American countries are as low as 2·2 cents (1·3d.) for molasses, or 6·70 cents per gallon (4d.) from cane alone, in both cases including raw material.

It is unlikely that we shall see the return of the small unit for industrial alcohol manufacture, except in the event that a motor fuel alcohol industry may be developed. In that case it would be inevitable that fuel alcohol plants would have to be distributed throughout the country wherever raw material existed in sufficient volume to justify their existence. But there is another possibility, which is that sugar producers will themselves enter gradually into the production of raw materials for the chemical industry. Using their own surplus molasses and cane, they would produce ethyl alcohol, acetic and lactic acids, etc., developing uses for a great part of this production in their own manufacturing processes and disposing of their surplus to outside markets. This scheme would have the great advantage of utilizing by-products for fertilizer and in this way maintaining the fertility of the soils on which the cane is grown.

Development of the Process of Centrifuging. P. Honig. *Archief Suikerind. Nederl.-Indië*, 1940, **1**, pp. 60-67.

In this article Dr. Honig describes the operation of the Roberts centrifugal installation at the Raceland factory, Louisiana, which he visited in 1938. This machine reaches maximum speed in a very short time, has a powerful water-cooled braking device, and provides means for automatically regulating the cycle of operations and for washing with a constant volume of water. It is capable of 1800, 2000 and even 2200 revs. per min., corresponding to a centrifugal force 2740 times gravity for a 40 in. machine, as compared with one of 921 for the 30 in. machines revolving at 1450 revs. per min. at present in use in Java.[4]

Three factors are of importance in obtaining a good separation of the molasses from the crystals. First, one must have a uniform size of crystal, preferably as large as possible, in order to present the smallest available surface, and allow of the free draining of the molasses. This condition can be obtained by improved boiling methods, as seeding with powdered sugar, maintaining a constant supersaturation by conductivity control, and regulating the vacuum with water in boiling off.

Second, it is necessary to lower the viscosity of the molasses previous to centrifuging by diluting with molasses or by warming, or by both methods. It has been found that the massecuite can be heated

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1 U.S. Patents 2,054,736 and 2,063,223. See also *I.S.J.*, 1937, p. 200; 1938, p. 485; 1939, p. 466. 2 U.S. Patent 2,169,244.
3 U.S. Department of Agriculture, Miscellaneous Publication No. 327.
4 Much information on the Roberts centrifugal of the Western States Machine Co., of New York, has already been published. See *I.S.J.*, 1938, pp. 282, 484; 1939, pp. 155, 198, 441.

up to the saturation temperature of the molasses at which no dissolution of crystal occurs. In this way it becomes possible to lower the viscosity of the molasses to be centrifuged by 40 to 50 per cent. with a correspondingly better syrup separation.

Third, there is the increase in the centrifugal force developed by the high-speed machine. Not only in the molasses much more completely separated, and also is more efficient, but the whole operation is now a more economical one. Application of these new processes has given a greater insight into the centrifuging of low-grade massecuites.

At Raceland, the procedure is to cool the m.c. to 38 to 40°C. in 24 hours, when the molasses becomes supersaturated. Without being diluted, the massecuites are pumped to the mixer above the machines where they are heated with water to the saturation temperature, which generally lies between 52 and 55°C., between which degrees it is centrifuged. In washing, use is made of water at 60 to 65°C. to the amount of 3 or 3½ litres per centrifugal, which is atomized at a pressure of 2 atmos. over the surface of the layer of sugar.

Particulars of the cycle of operations are as follows: reaching full speed, 2 min. to 2 min. 10 secs.; filling begins 15 secs. after starting, the speed then being 350 to 400 revs. per min.; filling takes 10 to 15 secs, the speed then being 400 to 500 revs. per min.; water covering lasts 5 secs. and generally takes place 5 min. after starting. Then the crystals are spun dry for 1 min. 20 secs. and the brakes applied, taking 30 to 40 secs. Emptying takes 60 to 70 secs., the total time taken for the whole of the cycle being from 8 min. to 8 min. 20 secs.

Other figure given are: 14·4 hl. of low-grade m.c. yielding about 820 kg. of sugar is dealt with per hour, or 560 kg. of sugar per sq. m. of gauze surface per hour, i.e., six times the average Java figure. In the syrup separation the wash syrup had a purity of 42 to 44 and the molasses thrown off one of 30 to 34. Per 200 kg. of molasses per cycle, the amount of wash syrup is 35 kg. containing 14 kg. of sugar. The great advantage of this high-speed centrifuging is that a sugar is obtained with a purity of about 99, which is in striking contrast with what is obtained in low-grade work in Java at the present time.

The Petree Process. COLIN W. WADDELL. *Sugar News*, 1940, **21**, pp. 223-224.

In the Petree Process the essential feature is the return of mud to the bagasse between mills, where, after considerable re-circulation in the mill juices, it is ultimately absorbed and carried to the fire-room.

Under Petree & Dorr Engineers, Inc., of New York, the original Petree Process was worked up in conjunction with Dorr Clarifiers and "compound clarification," and for a time this process gained wide popularity in many countries.

Advantages included: Elimination of the filter-press station (cloth, labour, maintenance, and sucrose lost). Elimination of the filter-cake disposal problem. Additional water available for maceration. Increase in "fuel" sent to fire-room. More uniform and often better clarification. Better sanitation due to higher temperatures.

Disadvantages included: Mill troubles (lower extraction, and heavy wear of rolls, trash plates, etc. due to grit, roll polishing, mill slippage, mill chokes). Fire-room troubles (wet and dirty bagasse, heavy clinker, more ash for removal, lost time cleaning fires). Mud re-circulation (only the fine *bagacillo* and firm flocs of mud were easily retained by the bagasse. Chemical control difficulties (no check being possible until after the clear juice left the primary clarifiers). Loss of valuable manure (nitrogen and organic matter being completely lost, while much P_2O_5 was rendered insoluble in the clinker).

Furthermore, it was urged that: the labour saved at the filter-presses was re-employed at the mills and fire-room; that the loss of sucrose in filter-cake which, theoretically, should be about the same with the Petree Process, in practice was much greater due to mill feeding difficulties.

Also that inversion avoided by running the plant "hot" and sterile was again lost by mud re-circulation and the consequent large volume of juice in process, while maintenance costs saved at the filter station were more than lost in the heavy roller shell wear, trash-plates, scrapers, conveyors, etc., handing the additional grit.

Fortunately, with the development of the continuous vacuum drum mud filter, there has come an opportunity for all contestants to the old Petree Process controversy to lay down their arms and save their faces by moving to this as the logical solution of the mud disposal problem.

Prevention of Deterioration of Sugar in Storage. (1) W. S. DAUBERT.[1] *The Sugar Journal* (Louisiana), **2**, pp. 24-26. (2) M. D. SCOTT[2] *Ibid.*, pp. 38-39.—(1) The proposed application of rigid sales quotas for Louisiana sugar processors has brought to the fore the problem of storing large quantities of sugar for protracted periods, and the author has accordingly outlined the literature on the subjects of manufacturing and warehousing. Assuming the sugar goes into the warehouse with the proper factor of safety, means should be taken to prevent absorption of any moisture, and the warehouse must not only be water-tight but air-tight. There is one method of preventing deposition of dew on the sugar or the absorption of moisture from the air, which can definitely be relied upon, and that is to keep the warehouse heated so that the temperature is always above the dew point, but both the initial

[1] Of Cinc are, La.   [2] American Sugar Refining Co., New Orleans.

cost of installation and the operating cost for long periods are important items. A warehouse should be constructed so as to be practically air-tight and keep out the moisture-laden air. (2) This second writer describes experiments in which raw sugars were stored in (*a*) an unheated and (*b*) a heated warehouse from November to August, during which period the pol in (*a*) fell from 96·4 to 92·35. Taking a 75 per cent. relative humidity as the critical point for raw sugar, some moisture must have been absorbed every day in the month from the data given. In (*b*), however, the pol. and moisture content had remained practically constant.

Fibres (including Bagasse), and their Possibilities (for making Paper) in Cuba. GIL PLÁ. *Proceedings of the 12th Annual Conference of the Cuban Association of Sugar Technologists*, pp. 240-247.—What determines if a plant is industrially useful for the manufacture of paper are the following conditions : Adaptability of its fibre, reliability of its supply, cost of gathering, transporting and processing ; and its storing qualities. It must be cheap enough to be able to resist competition from imported pulp from Sweden. Germany, Canada and the U.S. It is very difficult to manufacture mechanical pulp with bagasse fibre as it has not the same characteristics as that made from spruce. the difficulties making for the present high cost of this former material being the following : Its yield per unit of weight is lower compared with wood pulp ; the necessary chemicals are more costly in Cuba than in most other fibre producing countries ; and the interest on investment would be higher. Other fibres considered are : sisal, ramié and bamboo.

Mechanical Application of Lubricants to Sugar Mill Machinery. L W. BROADBRIDGE [1] *Proc. Queensland Soc. Sugar Cane Tech. 11th Conf.*, 1940, pp. 129-138.—In steam cylinder lubrication, with the exception of special valve and engine designs, such as Corliss valves, in which it is sometimes desirable to introduce the oil close to the valve working surfaces, the greatest economy of operation will be effected by utilizing the atomization method. Each case, however, must be carefully considered according to the design of the engine and the arrangement of the steam line. In general, the best results will be obtained by fitting the atomizer to a vertical length of pipe about 3 ft. prior to the engine stop valve, provided the design will permit this arrangement. An illustration (in the original article) shows the oil being delivered from the lubricator through a check valve to an atomizer placed in the centre of the steam pipe where the velocity of the steam is highest. There are now operating in Queensland many cane truck locos fitted with mechanical lubricators having atomizers fitted either direct to the valve chest or to the branch piece in the smoke box. Operating results have shown cylinder oil consumption in these locos to have been reduced by more than 30 per cent. Mechanical feeding is particularly advantageous in the case of mill roller bearings, for which, owing to their slow surface speeds and high unit bearing pressures, a very viscous lubricant is necessary to provide an effective oil film between journal and brass. A reliable pressure feed mechanical lubricator will feed a lubricant having a Saybolt viscosity at 210°F. of over 1000 secs. at rates less than ½ oz per hour regularly and continuously. Mill engine bearing, guides, etc., can also thus be lubricated to advantage from the view-point of economy. Apart from this saving, there is the safeguard in all its applications that the mechanical lubricator provides against failure due to inattention.

Use of Trisodium Phosphate in the Sugar Industry. M. W. NEUMANN. *Archief Suikerind. Nederl.-Indië*, 1940, **1**, pp. 51-56.—This chemical has come largely into use as a softening agent for water intended for high pressure boilers, especially in the U.S.A., it having been found that at pressures in the neighbourhood of 50 atmos. sodium carbonate is dissociated into NaOH and CO_2. Trisodium phosphate remains unaffected under such conditions of high pressure. It has been assumed that it reacts with Ca with the formation of tricalcium phosphate, which precipitate being slightly soluble would leave a residual hardness. In practice, however, it is found to soften water to zero point, and it is probable that a practically insoluble tetracalcium phosphate is formed. It may be added to the water in the boiler to form a sludge which can be blown out, and is useful at the beginning of the season when the amount of condensate available is insufficient for the softening of the make-up. A slight excess results in the formation of a thin layer of iron phosphate on the boiler surface, which protects it against corrosion. If a factory has modern boilers, e.g., of the Lamont type, which require to be kept free of sludge, a separate phosphate purification plant must be installed. T.s.p. is also recommended for the precipitation of Ca salts from juice after ordinary purification, its use being stated to avoid the formation of incrustations in the evaporators, and to remove any that may already have formed. Used for this purpose, it at the same time eliminates organic non-sugars and colouring matters. Other uses to which it may be put in the sugar factory are for the cleaning of filter-cloth by boiling in a 3 per cent. solution, and for the removal of oil from condensates, which may so be contaminated.

[1] Vacuum Oil Co. Pty. Ltd.

Review of Recent Patents.

Copies of specifications of patents with their drawings can be obtained on application to the following—*United Kingdom*: Patent Office, Sales Branch, 25, Southampton Buildings, Chancery Lane, London, W.C.2 (price 1s each). Abstracts of United Kingdom patents marked in our Review with a star (*) are reproduced with the permission of the Controller of H.M. Stationery Office, London, from the Group Abridgements issued by this Department. Sometimes only the drawings are so reproduced. *United States*: Commissioner of Patents, Washington, D.C. (price 10 cents each). *France*: L'Imprimerie Nationale, 87, rue Vieille, du Temple, Paris. *Germany*: Patentamt, Berlin, Germany.

UNITED STATES.

Rotary Crystallizer-Cooker. FERNAND LAFEUILLE, of Paris. 2,202,696. May 28th, 1940.

The present invention relates to improvements made in the rotary crystallizer-cookers described in U.S. Patents 1,649,601 of 1927, 1,653,712 also of 1927 and 1,815,852 of 1931. The improvements which are the object of the present invention are as follows:

1. Instead of being arranged in spiral or other like curves, the tubes of the bank are arranged in radial lines forming a number of groups, each comprising a plurality of tubes, said radial groups being connected two by two, four by four, or eight by eight, for forming eight, four or two banks of tubes of even number, this being done in such a manner that both the inlet orifice and the outlet orifice of each of the aforesaid banks are located at the same end of the drum.

2. The connexions between the tubes of the same plane or from one plane to another are effected by means of pipes which are welded on the tubes in question, without a joint of any kind.

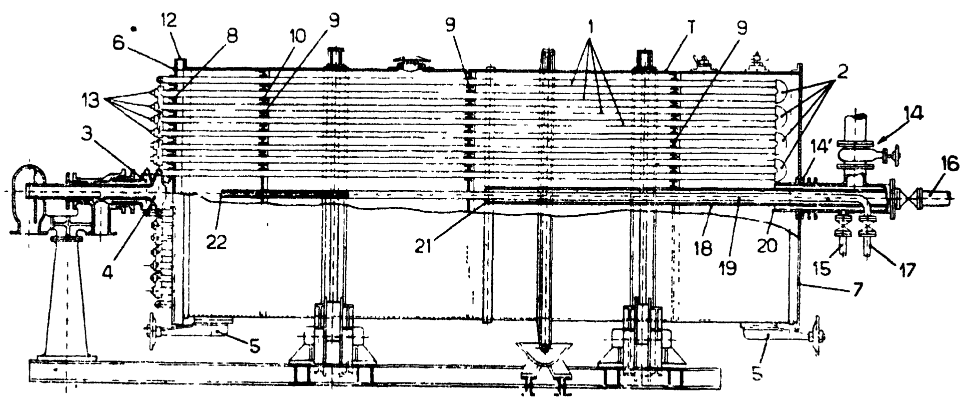
3. The apparatus is so arranged that the circulation of the water or of the steam is effected by starting from the central tube of one of the groups and the water or the steam in question flows in a zig-zag path through all the tubes of the plane, then through one of the connecting pipes opening into the groups of tubes of the adjacent plane, flows in a zig-zag course through the group in question and returns, after having thus flowed through an even number of plane groups, toward the end of the drum whence it started.

4. The filling and emptying doors of the apparatus are placed in the spaces which separate two groups of tubes.

5. All the tubes of the apparatus pass through a single end-plate of the drum and are welded on said plate so that they are integral with same, thereby being no tubes on the end-plate, which is located at the other end of the drum.

6. The tubes pass with a running fit in the orifices provided therefor in the arms of the radial supporting stays arranged in the drum.

7. In order to facilitate the removal and the replacing of the tubes of the apparatus, without danger of damaging the end-plate, this latter is secured, for each tube, to a bushing having a slightly larger diameter than the outside diameter of the tube itself, which bushing is welded externally on the end-plate in question, the tube being welded to the bushing in question.



8. In order to protect the tubes of the bank from wear, which is liable to occur in the long run at the points of contact of said tubes on said supporting stays, bushings made of a metal which is preferably softer than that of the tubes are fixed on said supporting stays, said bushings having a slightly larger internal diameter than the tubes which pass through them and substantially increasing the area of contact between the tube and its support.

9. In a modification, each of the tubes carries reinforcing rings at the points of contact with the supporting stays.

10. The means specified in 8 and 9 may be combined with a means which enables the points of contact of each tube with its supporting stays to be varied, said means consisting in interposing thicknesses at the spot where the end-plate carrying the tubes is connected to the body of the drum.

11. Opposite each of the tubes of the bank is located a threaded plug which enables an appropriate

device to be introduced into the corresponding tube for removing scale or for cleaning the inside of the tube in question.

12. The valve provided at the centre of the end-plate in which there are no tubes, through which valve the material to be treated is introduced into the apparatus, comprises a plurality of additional inlets each connected to an injection tube, these various tubes being arranged concentrically relatively to each other and opening at various arbitrarily chosen points on the length of the drum, which arrangement furthermore permits of a more homogeneous treatment of the mass.

13. The drum is driven through the intermediary of a speed varying device which enables the effects of the crystallization to be varied and the power necessary for driving the drum to be varied. (Figure shows a longitudinal view in partial vertical section of the rotary tubular crystallizer cooker provided with the improvements which are the object of the present invention).

Purification of Liquid Matter (using a Carbonaceous Material). Pieter Smit (assignor to N.V. Oct.-Mij. "Activit," of Amsterdam). 2,198,393. April 23rd, 1940.—Claim is made for the step of contacting a liquid to be purified with the reaction products from the destructive dehydration of a finely divided carbonaceous material by a dehydrating mineral acid (sulphuric and phosphoric acids) containing therein at least a substantial proportion of the free mineral acid used and having colloidal ion-exchanging properties, the step of separating said reaction products from the so-purified liquid and the step of treating said free mineral acid with a reactive substance capable of forming an insoluble precipitate therewith; the said precipitating step being conducted at least prior to the said separating step.

Recovering Sugar Crystals from Solution. August Ludwig and Calvin L. Swihart, of Menominee, Mich., U.S.A. 2,213,710. September 3rd, 1940.—Claim is made for the method of recovering sugar crystals from thick-juice which consists in first evaporating the thick-juice to proper concentration to constitute white massecuite and forming and separating white crystals therefrom to leave high green solution; then re-evaporating the said high green solution to proper concentration for removal of the balance of available crystals and forming and separating low raw crystals therefrom without washing them; then heating to about 60°C. and mingling a small quantity of said high green solution with said low raw crystals and permitting them to grow from said solution; then separating said low raw crystals from their mingled high green solution and washing them to form machine syrup; and then returning said machine syrup directly to said original high green solution and melting said low raw crystals and returning them directly to said thick-juice.

Obtaining Juice from Sugar Cane (and clarifying it). Armando S. Villasuso, of Ingenio Concepcion, Tucumán, Argentina. 2,206,341. July 2nd, 1940.—Claim is made for: The process of extracting the juice from sugar cane which consists in subjecting it to a plurality of stages of crushing operations, collecting the juices from the operations in independent volumes, allowing each volume of juice to settle, whereby lighter elements of the volume rise as foam and heavier elements settle as scum, conducting the foam from the first volume directly back to the first stage of crushing operation, conducting the scum from the first volume of juice into the second volume of juice, conducting the foam from the second volume of juice back to the first stage of crushing operation, conducting the juice of the second volume into the first volume of juice, subjecting the mass of crushed cane from the second stage of crushing operation to a third crushing operation, and conducting the juice from the third stage directly back to the cane passing through the first stage.

Cleansing Filter-Cloths. Anton Volz, of Ludwigshafen-on-the-Rhine (assignor to Hall Laboratories Inc., of Pittsburgh, Pa., U.S.A.). 2,198,847. April 30th, 1940.—Claim is made for the method of cleansing filter-cloths soiled with albuminous and alkaline earth deposits, which comprises soaking them in an aqueous solution of a molecularly dehydrated phosphate and thereafter in an aqueous nitrous acid solution.

Producing Carbonaceous Material. Alfred Oberle, of Edgemoor, Md., U.S.A. 2,201,050. May 14th, 1940.—Claim 4: The process of treating carbonaceous material which comprises subjecting it to treatment with superheated steam under super-atmospheric pressure, releasing the pressure, and subjecting the treated material to a vacuum treatment. [This for the production of activated carbon for decolorizing purposes].

Catalyst in Hydrogenation Reactions of Carbohydrates. Chas. W. Lenth and Robt. N. du Puis (assignors to Association of American Soap and Glycerin Producers, Inc., of New York). 2,201,235. May 21st, 1940.—Claim 3. A process for the hydrogenation of carbohydrates (mono- and di-saccharides) which comprises subjecting a mixture comprising hydrogen and carbohydrate in a liquid vehicle to temperatures of approximately 100°C. and upwards, and pressures of approximately 10 atmos. and upwards, while maintaining such mixture in contact with a catalyst resulting from heat treating a mixture of oxide-forming copper and aluminium compounds at temperatures of 750 to 1100°C. until a substantially acid-insoluble product is formed, and adding an alkaline promoter selected from the group of alkali carbonates.

Stock Exchange Quotations of Sugar Company Shares.

LONDON.

Company.	Quotation December 20th 1940	Quotation November 20th 1940	1940 Prices Highest.	1940 Prices Lowest.
Anglo-Ceylon & General Estates Co. (Ord. Stock)	$1\frac{3}{16}$ — $1\frac{5}{16}$ per £1 unit of stock	24/0 — 26/0 per £1 unit of Stock	30/3	17/7
Antigua Sugar Factory Ltd. (£1 Shares)	$\frac{1}{2}$ — $\frac{3}{4}$	$\frac{1}{2}$ — $\frac{3}{4}$	14/1$\frac{1}{2}$	11/3
Booker Bros., McConnell & Co. Ltd. (£1 Shares)	$2\frac{3}{8}$ — $2\frac{5}{8}$	$2\frac{1}{4}$ — $2\frac{1}{2}$	56/6	45/6
Caroni Ltd. (2/0 Ord. Shares)	1/0 — 1/6	1/0— 1/6	1/10$\frac{1}{2}$	9$\frac{1}{4}$d
(6% Cum. Pref. £1 Shares)	$\frac{15}{16}$ — $1\frac{1}{16}$	$\frac{15}{16}$ — 1	22/6	18/6
Gledhow-Chaka's Kraal Sugar Co. Ltd. (£1 Shares)	$1\frac{3}{16}$ — $1\frac{5}{16}$	$1\frac{3}{16}$ — $1\frac{5}{16}$	26/10$\frac{1}{2}$	22/0
Hulett, Sir J. L. & Sons Ltd. (£1 Shares)	22/0 — 23/0	20/9 — 21/9	27/9	18/6
Incomati Estates Ltd. (£1 Shares)	$\frac{3}{16}$ — $\frac{5}{16}$	$\frac{3}{16}$ — $\frac{5}{16}$	5/3	3/6
Leach's Argentine Estates Ltd. (10/0 units of Stock)	6/0 — 6/6	6/0x.d.6/6	8/9	4/6
Reynolds Bros. Ltd. (£1 Shares)	$1\frac{11}{16}$ — $1\frac{13}{16}$	$1\frac{9}{16}$ — $1\frac{11}{16}$	38/7$\frac{1}{2}$	29/6
St. Kitts (London) Sugar Factory Ltd. (£1 Shares)	$1\frac{5}{8}$ — $1\frac{7}{8}$	$1\frac{5}{8}$ — $1\frac{7}{8}$	36/3	36/3
Ste. Madeleine Sugar Co. Ltd. (Ordinary Stock)	11/6 — 13/0 per £1 unit of stock	10/0 — 12/6 per £1 unit of stock	16/4$\frac{1}{2}$	10/0
Sena Sugar Estates Ltd. (10/0 Shares)	$\frac{3}{16}$ — $\frac{1}{4}$	$\frac{3}{16}$ — $\frac{1}{4}$	7/10	3/10
Tate & Lyle Ltd. (£1 Shares)	46/6 — 47/6	47/9 — 48/9	57/9	35/0
Trinidad Sugar Estates Ltd. (Ord 5/0 units of Stock)	4/6 — 5/6	$\frac{1}{4}$ — $\frac{5}{16}$	6/3	3/0
United Molasses Co. Ltd. (6/8d. units of Stock)	22/9 — 23/3	21/9 — 22/3	28/3	15/0

NEW YORK (Common Shares).†

Name of Stock.	Par Value	Closing Price Dec 10th, 1940.	1940 Highest for the Year.	1940 Lowest for the Year
American Crystal Sugar Co.	No par	10	15$\frac{1}{4}$	8
American Sugar Refining Co.	$100	13$\frac{1}{2}$	23$\frac{3}{8}$	12$\frac{3}{4}$
Central Aguirre Associates	No par	18	26$\frac{1}{4}$	17
Cuban American Sugar Co.	$10	4$\frac{3}{8}$	8$\frac{7}{8}$	3$\frac{1}{2}$
Great Western Sugar Co.	No par	21$\frac{1}{4}$	29$\frac{1}{8}$	18$\frac{5}{8}$
South Puerto Rico Sugar Co.	No par	18$\frac{1}{4}$	30$\frac{3}{4}$	16

† Quotations are in American dollars and fractions thereof

United States, All Ports.

(Willett & Gray)

	1940 Long Tons.	1939 Long Tons.	1938 Long Tons.
Total Receipts, January 1st to November 9th	3,290,711	3,575,689	3,630,475
Meltings by Refiners „ „ „	3,399,704	3,451,280	3,548,471
Importers' Stock, November 9th	77,623	42,966	46,969
Refiners' Stock „ „	249,953	281,425	225,635
Total Stock „ „	327,576	324,391	272,604
	1939	1938	1937
Total Consumption for twelve months	5,648,513	5,604,051	5,690,583

Cuba.

(Willett & Gray)

	1940 Spanish Tons.	1939 Spanish Tons.	1938 Spanish Tons
Carry-over from previous crops	588,293	729,172	456,072
Authorized Production	2,753,903	2,696,517	2,950,000
	3,342,196	3,425,689	3,406,072
Exports since January 1st	1,886,775	2,387,503	2,412,512
Stock (entire Island) November 9th	1,455,421	1,038,186	993,560

The Market in New York.

The United States domestic market continued quiet during the earlier part of the period under review with both buyers and sellers disinclined to bid or offer for fear of moving the market against them. Reports from Washington on November 30th indicated a probable reduction in the beet acreage of 15 to 20 per cent. but as the amount of beet sugar released for home consumption is already controlled by the quota scheme, the above prospective decrease is probably intended to prevent any large surplus accumulating and the market did not appear to be affected by this news. Some days later, however, on December 9th, the Administration announced the respective quotas for 1941, which are as follows :—

	1941 Long Tons raw value.		1940 Long Tons raw value.	
Dom. Beet ..	1,383,837	against	1,383,837	unchanged.
Dom. Cane ..	375,149	,,	375,149	,,
Hawaii	837,533	,,	837,533	,,
Puerto Rico	712,484	,,	712,484	,,
Virgin Isles..	7,961	,,	7,961	,,
*Philippines	899,046	,,	877,179	+ 21,867 tons
Cuba	1,668,802	,,	1,562,317	+ 106,485 tons
Foreign	23,059	,,	21,540	+ 1,519 tons
	5,907,871	against	5,778,000	+ 129,871 tons

* Under the Independence Bill, the duty-free imports into the U.S. of Philippine sugar are restricted to 850,000 long tons and, therefore, it is not likely that the Philippines will ship in excess of this quantity.

Whilst this total figure is slightly higher than the final quota in 1940, which was regarded as fully ample to meet requirements, it is, nevertheless, lower than anticipated by the Trade, and the market jumped several points on this news. Prior to December 9th, the only business reported was 2,000 tons Philippines afloat and January arrival at the parity of 1·97 cents c. & f. New York, but on the day the quota was published an advance of 5 points was paid for a nearby parcel, whilst on the 10th the equivalent of 2·03 cents was realized for 17,000 tons. Two parcels changed hands on the following two days at 2·05 parity, but at this stage even this moderate demand faded out, and following an interval of a few days during which no sales were reported, a parcel of nearby Philippines changed hands on the basis of 2·00 cents, with business done at 2·03 cents mid-January arrival. During the last day or two, however, a better tendency has been in evidence owing to improved U.S. consumption figures for November, with further small sales January arrival at 2·03 cents c. & f.

A heavy demand for Refined was experienced on December 9th which continued up to the close of the market on the 12th when an advance of 5 points to 4·40 cents checked further business. Owing to the improving market reported above, a renewed demand was experienced on the 23rd.

Following an uneventful but steady period, the Domestic Futures market became firm on the quota news, but once the initial enthusiasm had evaporated a slightly easier tendency set in which continued for some days, but a slight recovery has since been witnessed. Quotations have moved in favour of sellers on balance and are 8 to 10 points higher compared with a month ago.

It was reported from New York at the end of November that plans had been submitted to the Quota Conference held in Washington whereby a large quantity of "World" raws, presumably mostly Cubas, could be refined in the United States under government auspices and stored there for eventual sale on a long-term credit. Whilst this arrangement would ease the position for Cuba, it does not appear to materially affect the general position at the moment, and, in any case, American trade circles are not inclined to "count their chickens" in advance. The trend of prices in the No. 4 Contract was unaffected by this news, and with the demand for Cuban sugar restricted to an occasional moderate outside enquiry, the general tendency has been towards slightly lower levels with quotations 6 to 3½ points down on balance.

C. Czarnikow, Ltd.

21, Mincing Lane,
London, E.C.3.
December 24th, 1940.

Colonial Agriculture Administration.—Sir Frank Stockdale has been appointed Comptroller for Development and Welfare in the West Indies. His successor as Agricultural Adviser to the Secretary of State for the Colonies is Dr. H. A. Tempany, who has been Assistant Adviser since 1936.

Treatment of Concrete.—Floors, tanks, troughs, gutters and the like, made of concrete, may be preserved against attack by the acids present in fresh and fermented cane juice by spraying with a 20 per cent. solution of sodium silicate, which combines with the free lime of the concrete forming calcium silicate, and precipitates SiO_2 in the interstices of the structure, the result being a surface which is very hard and durable and, moreover, is impervious to water, as well as being resistant to juice acids.

pH Installations in U.S.A.—In 1938 there were about 350 automatic *pH* recording installations in the Americas, of which number the cane sugar industry accounted for 125 antimony electrode units and the beet side for 100, the remainder being in use in water plants, paper mills, and the like. Laboratory indicating set-ups were, of course, more numerous, most of these now including the modern glass electrode system.

T.S.P.—Trisodium phosphate in a weak aqueous solution is being extensively used in the engineering trade for de-greasing. It is found particularly useful in the case of aluminium parts. In the sugar industry, it is found that bags and filter-cloths immersed for 5 to 10 min. in a solution containing about 1 lb. of the phosphate per 10 galls. of hot water will be well cleaned and softened and given a greater durability.

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THE INTERNATIONAL SUGAR JOURNAL

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Notes and Comments.

Winter Warfare.

The winter of 1940-41 is proving undoubtedly the grimmest on record so far as Europe is concerned. All the adjuncts to reasonable comfort in life are lacking in varying degrees, depending on the particular territory of that Continent. Even where essential food is not deficient in quantity, variety which is said to be the spice of life is severely curtailed, and home grown starchy foods tend to take the place of the proteins and fruits which in the past have been a mainstay of the import trade. Supplies of fuel in many countries, especially in those accustomed in normal times to import it from the more fortunate lands possessing coal strata, have been seriously affected by the disorganization of transport that is an accompaniment of military movements and bombing raids. It may be assumed that the worst sufferers are the unfortunate inhabitants of the small countries forcibly absorbed by the German Colossus, as well as of France both occupied and unoccupied; the products of their indigenous agricultural industries have from all accounts been requisitioned by their conquerors and largely sent to Germany to augment her own food supplies; the small balances left with the producers can hardly suffice to keep body and soul together. But even these industries cannot keep going without feeding stuffs and fertilizers, and here the British blockade of the German sphere must be having a gradually increasimg effect on supplies. Yet even America has realized the impracticability of shipping relief supplies to any of the victims within that sphere, because of the almost certainty that the Nazis would appropriate these or their equivalent for their own alimentary needs or else, what would be worse from the military point of view, use them, e.g., fats, as ingredients for munitions. So an appreciable portion of Europe has to starve, in order to hasten the day when its liberation from Nazi thraldom can be achieved.

War's Effect on Sugar.

In respect to the commodity in which we are most interested—sugar—there does not appear to be any marked shortage amongst European consumers, save probably in France whose 1940 sugar beet crop was largely wrecked by the overrunning last Spring of the northern beet tracts by the German invasion, and Norway which produces no sugar of its own. But sugar is everywhere rationed and it is probable that the ration by no means absorbs the total of sugar produced, and that a considerable surplus arises which is either stored for emergency or, what seems more likely, is utilized for non-consumable products. The sugar production of Germany proper—that is, as she existed on the outbreak of the present war—has clearly been considerably increased. There should not be any labour problem when we think of the large number of prisoners held by the Germans, and of the forcible conscription of labour from most of the conquered territories. Conditions are accordingly very different in the European beet sugar industry from what they were towards the end of the 1914-18 campaigns; there seem no grounds for supposing, so far, that the industry will encounter the severe curtailment which 20 years ago proved of such benefit to the rival cane sugar industry. For one thing, there has been no corresponding slaughter of manpower; modern mechanical methods achieve victories with an astonishingly small loss in personnel, as has been demonstrated not only in France but also in Africa.

As regards United Kingdom sugar supplies, all the indications are that this year the home beet industry will—weather permitting—produce a good average crop, which may cover nearly a third of the war time requirements. For the rest, ample cane sugar supplies are available in the countries of production. The deciding factor is obviously how much shipping can be spared to bring it to this country, and also the incidental luck of its actual convoy across the seas. But there is no suggestion as yet that the ration allowed must be further curtailed in the near future. The shipping problem is, however, obviously closely related to military commitments. A campaign such as that now being waged in Africa and in Albania cannot be kept supplied with its munitions and the needs of its commissariat without the services of a considerable fleet of cargo vessels. On the other hand, it may be observed that, as compared with 1917-18,

we have no longer to carry for France nor to aid Italy with her military and civil imports, which as the records reveal was no light task in those days.

Waiting for Hitler.

As we write these lines, indications multiply that Germany is at last being forced to come to the aid of Italy in the Mediterranean and to divert there a more or less considerable air force. In other words, she is being obliged to face her pet military aversion, a war on more than one front. For whatever she does eventually in the Mediterranean, her principal task remains the attempted subjugation of Great Britain, and this can to all appearances be achieved solely by a successful invasion. So the dangers of a combined assault by air and sea on this country, if temporarily scotched last Autumn, are once more very much to the fore, and it seems very likely that within the next two months the attempt will be made with increased ferocity and with greater resources than were available a few months ago. But the defence has also had time to strengthen its resources, and while few if any expert observers would hazard the view that it is impossible for the enemy to score some preliminary points in his attack, the very thoroughness of the preparations to resist it and the existence in particular of an appreciable sea barrier, should ensure the ultimate and, it is to be hoped, prompt defeat of what can at best be looked on as a very desperate venture, planned with utter disregard of human lives. But while it is in full swing, England may well experience an ordeal unique in her annals and produce a resolution of purpose just as unique, in which every civilian may be expected to share.

Alcohol Production in Australia.

In our October number[1] in the course of discussing Australia's growing need for power alcohol we gave some figures relating to the financial side of the problem of producing alcohol from cane juice, as drawn up by the Queensland Cane Growers' Council. These figures were admittedly only tentative and did not take into consideration the question of using as raw material the large amount of molasses which would be available. Since then Mr. C. W. WADDELL, who has just lately arrived in Queensland after some years of working in the Philippines where alcohol production in the sugar industry is already a live factor, has carried out an investigation for the consideration of the Council in its dealings with the Power Alcohol Commission. We gather that the following are some of the conclusions to which he has come in respect to this urgent problem.

It is believed that the costs of converting sugar cane products into pure alcohol (including transport to blending depôts in the cities) would be in the vicinity of 9d. per gallon. The lowest economical cost of producing a ton of 94 N.T. sugar is put at £10-10-0 at the mill, while it is assumed that 125 gallons[2] of pure alcohol can be produced from such sugar, that is, the raw material would cost at least 1s. 8·16d. per gallon, so that with the above 9d. the total cost of alcohol at the blending depôt comes to 2s. 5·16d. per gallon. Now, the Power Alcohol Committee are not prepared to recommend a guaranteed duty-free price higher than 1s. 9d. per gallon, so that only 1s. per gallon alcohol is available for the raw material, which means that a ton of 94 N.T. sugar would fetch only £6-5-0 at the mill, so the conclusion is that using sugar juice only for alcohol is an uneconomic proposition in Australia.

The gap then can only be bridged by utilizing at least in part the large supplies of waste molasses. With every ton of sugar produced in Queensland about 0·176 ton of final molasses is available, which is calculated to yield about 60 gallons of alcohol. On the basis of 1s. per gallon for raw material this is worth 60s. for alcohol production, as compared with the present market price for molasses of about 16s. per ton. The big difference in price represents an additional revenue which, according to Mr. WADDELL, could be applied to a small percentage of the sugar crop to bring up the price of such portion of sugar used for alcohol from £6-5-0 to £10-10-0; something like 80 per cent. of the molasses could be made available, it is calculated, for distilleries if a price of anything like £3 could be paid for it. No molasses is at present wasted in Queensland, but 35 per cent. of the supply, at present disposed of as manure and fuel, is only justified by the low price of 16s., and the 20 per cent. used for stock feed would be largely diverted to alcohol at the higher price offered; so at the present rate of production some 104,000 tons of molasses could be rendered available for distillation to produce over six million gallons of power alcohol.

In respect to cost of manufacture, the cheapest method is undoubtedly to employ a large Juice-Mill Distillery, crushing cane for alcohol only, at about 6¾d. per gallon. Other methods are by means of a small distillery adjunct to a factory, using final molasses or "B" syrup at a cost of 9d., or large central distilleries, either in the centre of a group of sugar factories or in a capital city, the cost of manufacture being respectively 9½d. and 11½d. Disregarding for the moment the large juice-mill distillery, the small Adjunct Distillery is claimed to have advantages over the others in that it eliminates cost of transport of raw materials, gives facilities for slop disposal on the cane fields, and can employ the surplus steam from the sugar mill, while the facilities are at hand for converting if desired a given fraction of the sugar crop into alcohol by simply pumping the "B" syrups direct to the distillery, and thereby reducing the tasks of the boiling, crystallizing and centrifugalling stations. For these and other

[1] Page 338.

[2] The figure of 140 gallons mentioned in our October data would appear to have been on the high side.

reasons it is urged that the small adjunct distillery using, say, 90 per cent. of the "B" syrup as raw material (10 per cent. being retained for stock feed) forms an ideal combination within the sugar industry, and in Mr. WADDELL'S view should be tried out in a number of districts before the sugar industrialists consider the alternative of turning a larger quantity of sugar juice into alcohol.

With regard to a large Juice-Mill Distillery, it is argued that while its manufacturing costs are lower than in the case of the other alternatives, that is only so if it confines itself to converting sugar juice to alcohol. If, however, it takes into consideration the large supplies of final molasses available from other mills and converts these also, then the cost of this operation (including transport expenses) raises the average cost of manufacture to a figure which saves little if anything over the costs of an adjunct distillery. On the other hand, the juice-mill distillery loses the benefit of the fertilizer ingredients of the molasses in all but one of the cane districts.

This problem of centralization at a large distillery, or decentralization amongst a number of sugar factories themselves, is one that is exercizing the minds of sugar industrialists in South Africa also, where concern is felt at the possibility of supplies of imported oil being affected and the need to have a home production of cane spirit is increasingly realized. We reproduce on another page an article on the subject by a South African sugar technologist which surveys the pros and cons of the problem. The writer (Mr. G. C. DYMOND) evidently favours decentralization, such as is successfully practised in Brazil. It is also, it may be observed, operating successfully in the Philippines and India. The fact that Australia is inclined to look with some favour on centralization is probably due to the policy adopted by the Colonial Sugar Refining Company, which has been a pioneer in producing sugar alcohol in the Commonwealth. One less obvious factor, to which Mr. DYMOND rightly attaches importance, is the ability of the distillery adjunct to a sugar estate to use the dunder refuse as an ingredient for the manufacture of humus for the fields. The cane trash, the dung (if any), the dunder, the green material, the water—these ingredients for humus composting can be collected in the vicinity and the product be used on the estate fields. Incidentally, Mr. DYMOND suggests some harvesting methods that would facilitate the economical collection of the trash. Anyhow, when as at the present day a growing importance is being attached to the production of humus for fertilizing the cane fields as compared with the too prevalent resort to artificials, the ability of the adjunct distillery to contribute its share to the raw materials is one that should be taken into account in assessing the comparative profitableness of the distillery plant as a unit in the *ensemble* of a sugar industry.

U.S.A. 1941 Sugar Quota.

As we mentioned briefly last month, the U.S. Department of Agriculture on December 7th announced that the total supply of sugar required to meet consumers' needs for 1941 has been determined at 6,616,817 short tons, raw value. On the basis of this determination, the quotas for the various sugar-producing areas are as follows, the final quotas for the two previous years being given for comparison :[1]

	Initial 1941 Quota.	Final 1940 Quota.	Final 1939 Quota.
Cuba	1,869,060	1,749,744	1,932,343
Hawaii	938,037	938,037	948,218
Philippines	1,006,931	982,441	981,912
Puerto Rico	797,982	797,982	806,642
Virgin Islands	8,916	8,916	9,013
Foreign*	25,826	24,177	85,812
Total Offshore Areas..	4,646,752	4,501,297	4,763,940
U.S. Beet	1,549,898	1,549,898	1,566,719
Continental Cane†....	420,167	420,167	424,727
Total Continental ..	1,970,065	1,970,065	1,991,446
Grand Total	6,616,817	6,471,362	6,755,386

* Other than Cuba. † Louisiana and Florida.

The Sugar Act of 1937 directed the Secretary of Agriculture to determine in December of each year the amount needed to meet requirements of consumers for the following calendar year. This determination must be made on the basis of a formula specified in the Act, which establishes, as a base figure for the determination, the quantity of sugar distributed in the 12 months ending October 31st of the prior year and takes into consideration deficiencies or surpluses in inventories of sugar, and changes in consumption.

The Future of the Philippines.

The present Commonwealth of the Philippines, set up under the Independence Act of 1934, has a little over five years more to run before complete independence ensues for these islands. From July, 1946, onwards, unless in the meantime the United States modifies its attitude towards them, the Philippines will be left to work out their own economic salvation, deprived of their customary preferential markets in the U.S.A. and with little prospect, it would seem, of securing other outlets for their staple products, once they have to compete on an open world market.

A well-informed correspondent of the *Economist*, discussing the outlook in a recent issue of that weekly, gave a summary of the political vicissitudes of these islands since they were freed from Spanish domination in 1898. He described this transfer to American control as the most interesting of the few adventures in imperialism that the United States have ventured on. At the start trouble was encountered with the Filipinos, for these, freed from 400 years of

1 Figures derived from Lamborn's Market Report.

Spanish rule, thought they were free enough to set up a republic of their own; it took their liberators some time, and a war, to convince them that they were mistaken, and by 1900 their colonial status was firmly established. This gave the Philippines some great advantages; the past 40 years has been an era of trade preferences and orderly Government, and by 1933 home rule was sufficiently developed for the islands' legislature to be strong enough to reject the spurious independence which at first certain business interests in the United States tried to force on them.

Under the Independence Act of 1934 a National Assembly was set up and a Commonwealth President elected. In internal affairs they became broadly autonomous, but continued to owe allegiance to the United States for the ten years ending in 1946. The United States meantime controls foreign affairs and the public debt, and the President at Washington must approve acts affecting currency, coinage, imports, exports and migration. Moreover, American military and naval forces stay on the spot during the life of the Commonwealth, and, after independence, the navy and its fueling stations will remain for an indefinite period.

The Philippines is an archipelago of 7,000 islands lying about 500 miles off the south-east coast of Asia, and at the nearest point only 65 miles from Japanese Formosa; they form a kind of isosceles triangle guarding the northern approaches to the Dutch East Indies, so they are of considerable strategic importance at a time when Japan is making marked advances south of China proper. The uncertainty of the international outlook in those waters is, in fact, a danger to American major interests, and this may yet prove an over-riding factor in deciding the United States that it is not to their ultimate interest to leave the Philippines to carry on unaided and with no further incentive to take sides with the country which colonized them 40 years ago.

Apart from the naval problem, the economic outlook must call for definite adjustment. For years past the trade of the Philippines has looked increasingly to the U.S.A. for its markets, especially for sugar, and by 1938 the proportion of Philippine exports that went to the States had grown to four-fifths of the total. On the import side, the predominance of the U.S.A., though not so marked, is still decisive, the two-way traffic having been stimulated by preferential duties, and grown up at the expense of French and English traders. With the coming of complete independence, unless generous concessions are made, it would seem that the whole economy of the Philippines must fall into ruins, as the island's sugar industry could hardly survive in the face of competition from Cuba and Java; and as for the subsidiary industries, they face the hostility of American mainland business interests who would not tolerate their competition willingly. Yet the desirability of the United States not casting the islands adrift economically looms larger in the present state of international affairs, and a compromise may yet be achieved. Actually, as a result of Mr. ROOSEVELT'S initiative, a U.S.-P.I. Committee has been formed, which proposed that the period of trade adjustment should be extended to 1960, both sets of import duties being raised gradually during the first 14 years of independence. So far, Congress has rejected the suggestion, limiting the concessions to various items during the 1940-46 period. With the return of Mr. ROOSEVELT to power for a further four years, the problem may well be attacked anew with a chance of better success. What seems clear is that the Philippines must be given further time to re-adjust their economic sphere if they are to survive; democratic America cannot ultimately fail to recognize that (as our contemporary puts it) "forty years of union carries with it serious obligations for the future on the part of the stronger member."

International Sugar Council.

We learn that the International Sugar Council met in London on the 6th January, 1941, when Delegates representing seventy-six out of the total of one hundred votes were present. The Council re-elected General Sir HUGH ELLES, Chief British Delegate, as Chairman and Dr. G. H. C. HART, head of the Netherlands Delegation, as Vice-Chairman for the current quota year.

The Delegations present were unanimously in favour of carrying on the International Sugar Agreement. They formally adopted various decisions reached at an informal Meeting on 23rd August, 1940, including a decision that, without creating a precedent, the export quotas for the Free Market adopted for the third quota year ended 31st August, 1940 would be maintained for the fourth year ending 31st August, 1941, instead of reverting to the larger basic quotas; this decision being subject to review should there be a radical change in the world situation during the course of the quota year. (The decision is subject to confirmation by one Delegation which was awaiting a cable from its Government).

The Council also set up a Sub-Committee under the Chairmanship of Dr. G. H. C. HART, consisting of representatives of the Australian, Cuban, Dominican, Netherlands, United States and United Kingdom Delegations, to study the present and post-war general and statistical position of sugar, and to report to the Council at its next Meeting.

This decision to carry on, in spite of the disorganization caused by the war, is to be welcomed, since it will ensure that when the war is over the world sugar industry can resume economic control more nearly at the point where it left off, instead of being faced with the prospect of an unbalanced ratio between supply and demand.

Molasses and Manure.

Many attempts have been made to use the excess production of molasses as fertilizer and, indeed, the consumption by this means must be very considerable though it would be difficult to obtain any reliable figure for this. The fact remains, however, that the obstacles in the way of any general adoption of molasses in a fertilizer programme are such that there still exists a considerable potential use in this direction for the excess supply if these difficulties could be overcome. These difficulties centre on the fact that the incorporation of molasses in the soil involves a process of fermentation, a biological process; and such biological processes are exceedingly susceptible to the environmental conditions. The difficulties encountered are, in fact and in many ways, very similar to those encountered in the practice of green-manuring. Green-manuring requires for its successful adoption a fairly assured sequence of climatic conditions favourable for the process, and there are few countries in the world where such a sequence can be guaranteed. Primarily this is a question of securing the correct degree of humidity, aeration and soil neutrality for the activation of those bacteria, the end products of whose action is that richly nitrogenous complex commonly called humus. Failure to secure each and every one of those conditions results in a diminished benefit and may even render the last condition of the soil worse than the first. The main difference between green-manuring and the application of molasses lies in the vastly lower resistance of the latter to the agents of decomposition. The vigour of the bacterial action may be such that the supply of available nitrogen in the soil becomes exhausted, with deleterious effect to any standing crop.

Hence has arisen the practice of applying molasses to the fallow at least some weeks before planting the crop. Even so, difficulties arise, as when the conditions are such that soil acidity develops, and an actual loss of nitrogen may occur, while there are involved further difficulties of a mechanical nature and concerned in the means of distributing the molasses sufficiently evenly over the land.

Thoughts, under these circumstances, naturally turn to the possibility of pre-treating molasses, thus applying in this case the same principle of composting the green-manure in place of turning it in directly. With the added opportunities for control which the method offers, the end product is more assured, but, against this, must be set the cost of handling. Feelers in this direction have been put out in certain experiments by H. D. Sen and an account of these appears in an article entitled Conversion of Cane Molasses into Manure by the Biological Method and the Results of the Cropping Tests with the Manures prepared.[1]

The unit plant used in this process consists of three masonry tanks 10 ft. × 10 ft. × 8 ft. (approx. 5,000 gallons) supplied with blowers so set that the sludge at the bottom is not disturbed. Into the first of these are placed 75 maunds of molasses and an equal quantity of filter-press mud, thoroughly incorporated with 3,000 gallons water, and 60 gallons of wash added. This wash is a culture of the pure yeast *S. ellipsoidus* in dilute molasses (one maund in 60 gallons water) and is used on the third day. A further addition of half a maund of Niciphos is made and aeration started with intermittent addition of lime every 4 hours. After 24 hours the supernatant liquor is transferred to the second tank and the process repeated. On the third day the liquor from the second tank is transferred to the third tank, in each case half a maund of Niciphos being added to the transferred liquor. On the sixth day the sludge of all three tanks is collected into shallow masonry beds, sun-dried and bagged as manure ready for the fields.

The week's product by this method is some 172 mds. manure and 9,000 galls. fermented liquor of high manurial value produced from 240 mds. molasses and an equal quantity of filter-press mud. The cost, with molasses at 4 as. per md., filter-press mud at 6 pies per md., Niciphos at 6 rs. per md., lime at 8 as. per md. and labour at 5 as. per day, works out at 12 annas per md. Variants of the method outlined above indicated that the yield of yeast was least when aeration and intermittent neutralization were not practised, and increased some 1·5 times when these practices were adopted. The use of ammonium sulphate increased the yield some three times, and that of Niciphos some six times the yield obtained without aeration and neutralization. Further, yield increases with the dilution of the molasses.

The paper further describes a complex series of field trials comparing manure produced by the above method using (1) molasses, (2) molasses and filter-press mud, (3) molasses directly applied, and (4) castor cake, all four being applied at rates giving (1) 60 lbs and (2) 120 lbs. nitrogen per acre. Across this series of manurial applications a further complexity was introduced by use of the three canes, Co 313 (early), Co 312 (medium) and Co 331 (late).

The results are set out in considerable detail. Unfortunately the date of application of the manurial dressings is not given, a point of considerable importance especially in the case of the directly applied molasses, but the general trend of the results is clear. Molasses directly applied has generally shown a depressant effect which is more marked in the case of the heavier dressings. The manure prepared from molasses and molasses plus filter press-cake gave definitely increased yields at least comparable to

[1] *Ind. J. Agric. Sci.*, 1940, 10, p. 172.

those resulting from the use of castor cake of the same value as measured by nitrogen content.

Less directly connected with the question of the use of molasses but having a bearing on that matter in that the carbon nitrogen balance is involved, is a series of four articles, the first by C. N. ACHARYA and V. SUBRAHMANYAN and the last three by the first of these, entitled The Hot Fermentation Process for Composting Town Refuse and other Waste Material.[1] These investigators point out that in the aerobic processes usually adopted, heavy losses of carbon and nitrogen occur and that the loss of nitrogen is particularly severe in composting town wastes and may amount to over 50 per cent. The night soil used has a C : N ratio of about 8 : 1 while that of the street sweepings is also high owing to the high nitrogen content of the leaves which form a large part of the sweepings. It is difficult to raise the initial ratio to the desirable 30 : 1. The series records the experience obtained with what is termed the hot fermentation process, the essential principle of which is that the material is allowed to decompose aerobically under the optimum conditions of moisture and nitrogen supply for a limited period (5 to 6 days), during which a high temperature (60 to 70°C.) is reached, and the later cutting off of the supply of air by compacting the mass.

What may be termed a preliminary excursus into the subject is given in the second paper, which describes experiments designed to determine the optimum conditions for satisfactory decomposition. In it the materials used were street sweepings divided into two fractions, the soil fraction consisting mainly of soil and ash, and the leaf fraction consisting, as its name implies, mainly of leaves and organic matter, and night-soil. Requisite amounts of these three substances together with the desired amount of water were thoroughly mixed and placed in concrete containers 8 cub. ft. in capacity. After the preliminary period of 5 to 6 days, during which an aerobic fermentation was established, the contents were pressed down and sealed with mud-paste and earth for a period of 2½ to 3 months.

The results show that the relation between the amounts of the three components have a very material influence on the result. Taking the recovery of nitrogen as the measure of success, the optimum mixture consists of one part by weight leaf fraction, one to two parts soil fraction, and two parts night-soil. Second only in importance to the material is the moisture content. This should initially lie between 50 and 55 per cent., lower amounts resulting in insufficient humification and higher amounts to the accumulation of a liquid sludge. Additions of lime and superphosphate showed no beneficial action while the addition of nitrogenous starters only served to increase the loss of nitrogen. Under the optimum conditions as so defined, temperature rose rapidly to 65 to 70°C. by the fourth day, the highest reading being at 20 cm. depth in the early stages and at 40 cm. later.

Tests of the various possible containers showed that a considerable loss of both nitrogen and carbon took place if the containers were unlined. In a choice between above-ground heaps and trenches, the preference was for the latter as promoting more uniform decomposition.

The third paper describes a number of experiments using (1) rice straw and (2) town refuse, with a series of starters ranging from inorganic substances, such as sulphate of ammonia, to organic substances such as cattle urine and droppings and night-soil, and it gives a comparison of these under the hot fermentation and the aerobic processes. In all cases the hot fermentation process gave a much higher yield of manure as measured by the organic matter contained, the ratio varying from 1·5 to 3 times. Also it conserved the original nitrogen to a greater extent. Much depends, however, on the initial C : N ratio.

The fourth paper draws a like comparison between the hot fermentation process, using town wastes and night-soil, and the various accepted methods of preparing poudrettes from night-soil. Direct drying of night-soil involves heavy losses of valuable matter through liquefaction and seepage. The preparation of wood-ash-night-soil has much to recommend it, but it has the disadvantage of requiring an adequate supply of wood-ash ; nor does it solve the problem of the disposal of street wastes. With the latter by the hot fermentation process, approximately a double yield results and a net income of nearly 1·5 times. A combination of these two processes might prove the most remunerative. In these arguments the author has in mind municipalities and town authorities but the same arguments would be valid in the case of labour lines ; it is mainly a question of relative amounts of night-soil and other wastes.

Seeing the importance of widening the C : N ratio of the initial complex when handling such materials as town wastes and night-soil, the possibility of effecting this by the addition of that readily decomposable product of the sugar factory, molasses, did not escape notice. It was found, however, that, whilst a decreased loss of nitrogen occurred as the result of such addition, an increased loss of organic matter resulted and the gain, on balance, did not cover the additional expense.

H. M. L.

PERUVIAN SUGAR CROPS.—The 1940-41 sugar crop in Peru is estimated at 443,000 long tons, raw value, according to Lamborn, this comparing with 459,000 tons in 1939-40. Of this last season's actual production, 318,400 tons was exported, 100,200 tons was consumed locally, and 40,400 tons added to stock. The principal exports were 136,700 long tons to Chile, 47,100 tons to the United Kingdom, 50,800 to the U.S.A., 21,000 to French Morocco, and 14,500 tons to Russia.

[1] *Indian J. Agric. Sci.*, 1939, **9**, p. 741 ; 1939, **9**, p. 817 ; 1940, **10**, pp. 448, 473.

The Intercropping of Sugar Cane.

The idea of intercropping sugar cane with various legumes has been suggested on several occasions and has been tried, particularly in Mauritius. Here DE SORNAY as long ago as 1916 advocated the practice and suggested the soy bean for the purpose. The benefits expected are various. In addition to the cash return from such produce as may be harvested, there might be expected to be agricultural benefits from the manurial value of the residues, from the control of weeds, and from the protection of the soil against erosion or, at least, against a compacting of the soil which would necessitate additional cultivation. Clearly, additional expense is involved in the practice, but it was estimated that this would be covered by the value of the product. The aspect which appears, however, to have received inadequate attention, is this: what effect on the cane crop has such leguminous intercropping? It is an answer to this question which a recent paper seeks to provide.[1]

The combined results of two experiments, one during the crop season October, 1935, to February, 1937, and the other during the season September, 1936, to February, 1938, are given. In each case replicated plots were laid down covering the four treatments, (1) control, (2) intercropped with peanut, (3) intercropped with soy bean, and (4) dressed with sulphate of ammonia (20·6 per cent. available N) applied round the set before covering at the rate of 300 kg. per hectare. Cane seed consisted of sets with three or more eyes soaked in running water for 36 hours before planting and the sets were planted in furrows 1 metre apart with 50 cm. between the sets. Before covering the furrows two or three seeds of the respective legume were placed in the row between the sets. Parenthetically it may be remarked that the reason for planting these between the sets in the row and not between the rows, a location which would appear likely to interfere less with the growth of the cane, is not explained but may be found in the nature of the subsequent cultural operations.

A difference between the plots early became apparent. In the control plots germination of the cane sets averaged in the first experiment 88·98 $\pm$ 0·60, in the ammonium sulphate plots 93·53 $\pm$ 0·42, in the peanut plots 75·49 $\pm$ 1·10, and in the soy bean plots 79·34 $\pm$ 1·28 per cent. The effect of sulphate of ammonia on germination, thus, appeared to be beneficial, whilst the intercropping of legumes proved harmful. The legumes germinated some three weeks earlier than the cane, and the explanation, it is suggested, is that while the legumes acted as competitors for the limited amount of moisture present, the sulphate of ammonia acted as an absorbent of moisture.

Later, the most abundant growth of weeds occurred in the plots with sulphate of ammonia with relatively few in the intercropped plots. Unfortunately, the rapid growth of the legumes not only suppressed the weeds but checked the growth of the cane, to the extent designated by the term stunted. Taking the figures for tillering from the second experiment as a measure of relative growth (millable stalks per stool), the respective figures were: for the control 4·03, for the sulphate of ammonia plots 4·80, for the peanut plots 3·63, and for the soy bean plots 3·80 stalks. Throughout there was no significant difference in the production of non-millable stalks.

The effect of this stunting was apparent in the crop returns. In the first experiment the yield of cane in tons per hectare was: for the control 68·07, for sulphate of ammonia 78·14, for peanut 58·58, and for soy bean 62·57; and the yield of sugar (piculs per hectare) for the control 97·03, for sulphate of ammonia 96·55, for peanut 60·32, and for soy bean 70·63. In the second experiment the respective figures for cane yield were 70·32, 77·11, 56·94 and 66·53, and for yield of sugar 103·45, 125·01, 96·00 and 96·52. A comparison of the detailed experimental results shows one point of difference between the two experiments. While none of the three treatments affected the sucrose content of the cane in the second experiment, in the first experiment a significant lowering of the yield of sugar per ton of cane resulted both from applications of sulphate of ammonia and interculture with peanuts. The respective yields of sugar per ton of cane for the control, ammonium sulphate, peanut and soy bean were (in piculs) in the first experiment 1·44, 1·22, 1·02 and 1·33, and in the second experiment 1·49, 1·61, 1·71 and 1·46.

Details are not given from which it would be possible to draw up a balance sheet of the result. Against the lower yield of sugar must be placed the additional income from the produce derived from the leguminous crop. The yields of peanut ranged in the first experiments from 26·48 to 16·36 cavans per hectare, with an average of 21·71 cavans (1 cavan = 75 quarts at 3·25 pesos per cavan) and of soy bean 5·35 to 3·21 cavans, with an average of 3·87 cavans (at 12·50 pesos). In the second experiment the average yield of peanuts was 23·55 cavans, but the yield of soy beans fell to 1·78 cavans. These yields are considerably below those obtained from pure cultures of these legumes.

H. M. L.

[1] "The Comparative Effects of Soy Bean and Peanut planted with Sugar Cane and Ammonium Sulphate Fertilizer upon the Yield o Cane." V. C. ALMA and J. P TIANGSING. *Philippine Agric.*, 1940, **29**, p. 20.

The Chlorotic Streak Disease of Sugar Cane.

The first report of the disease for which the name, chlorotic streak, was adopted at the 1932 Congress of the International Society of Sugar Cane Technologists, was made by MARTIN in 1930 from observations in 1929. This report referred to POJ 36 cane on the Olaa Sugar Company's estate in Hawaii, and he recognized the similarity of the disease with that observed by WILBRINK in Java and there termed Fourth Disease. Since then the disease has been identified in Puerto Rico, Queensland, Mauritius and Louisiana.

As the name implies, the characteristic symptom is the presence of one or more yellowish streaks on the leaves, following the veins but rarely extending into the sheath. These streaks are typically diffuse in outline and are thus, readily distinguished from the sharply defined lines of leaf scald. Where several streaks occur on the leaf, necrotic areas may be found. Other symptoms are red discoloration of the vascular bundles at the nodes and a more or less evident depression of growth. The occurrence of the disease, at least in its more serious manifestation, is limited to the wetter districts. There is considerable difference in varietal susceptibility and the planting of diseased cuttings even of susceptible varieties in dry localities is followed by a temporary appearance of mild symptoms. Under these conditions transmission of the disease does not appear to occur.

From the commercial aspect the important fact emerged that, while the disease is transmitted by cane cuttings, an almost complete control was obtained by treating the cuttings in water at 52°C. for 20 minutes. Many facts, such as the contracting of the disease by a number of new hybrid seedlings annually, however, indicate only too clearly that some other method of transmission exists.

The early discovery of a practical means of control in the hot-water treatment is, perhaps, the reason for the obscurity which hangs about the true nature of the disease. Recent investigations in Hawaii, however, suggest that it is due to a Chytrid, one of a group of obscure and primitive fungi classified among the Phycomycetes, and are described by C. W. CARPENTER.[1]

All the earlier efforts to trace a causative organism failed. Not only was none of the isolated organisms found to be capable of re-infection, but all attempts at the direct or indirect transmission of the disease failed; even contact planting in the presence of numerous potential vector insects failed. These failures led to a more detailed study of the necrotic tissues, and here peculiar spherical spores, similar to those previously reported from diseased tissues but of which the significance was not then recognized, were found which could only be grown in culture in association with bacteria. These cultures yielded a primitive fungus with amoeboid stages, which is suspected, but not yet proved, to be related to the Chytrid referred to above.

The claim of the organism here considered tentatively to be a Chytrid is that it entirely lacks a mycelial stage. In its most conspicuous form it is observed as dense black spheres scattered within the cells of the parenchyma and often taking the shape of the cells within which they lie. Smaller spheres are hyaline or grey. Their escape from earlier observation appears to be due to their localization along longitudinal lines. The observations made on these bodies show a strong similarity to the *Physoderma* disease of maize (*P. zeae maydis*). Numerous stages in the development of the organism are described and illustrated, but these have not yet been linked up to form a connected life history.

The certain similarity borne by the organism to the *Physoderma* of maize suggests a comparison between the two not confined to the morphological aspect. In both the more important factors controlling the disease are humidity and temperature. In the case of maize, infection takes place in those parts of the leaf, leaf sheaths and culms so protected from sun and wind that rain-water remains for protracted periods. The disease is most common, therefore, in low-lying wet areas where the atmosphere is moist and the water remains in the sheath sufficiently long for spores to develop. These are the conditions which are found to favour streak disease in the cane, though the system of vegetative propagation adopted with it makes the cane set the most important means of distribution.

Another feature of the disease may be referred to; it is the occurrence of yellow or red gum deposits in the conducting vessels especially at the nodes. Though these deposits may plug the vessels, their occurrence is not sufficient to explain the streaking of the leaf. There appears to be an association of the plasmodial bodies and small spheres of the presumed Chytrid with the chloroplasts which would more probably account for the phenomenon of streaking. Clearly a good deal of further work is required before the situation with regard to this disease is fully cleared up.

H. M. L.

JAVA SHIPMENTS.—A Java correspondent of Willett & Gray, of New York, in the course of detailing the very poor shipments of Java sugar during August last, stated that shipments to the U.K. had been delayed by lack of available tonnage. "It cannot be denied that steamers suffer from big delays. However, they do arrive at destination, and that's the main thing. We receive quite a number of periodicals from England; since the outbreak of war not one in the series is missing." Which speaks for the ability of the British Navy to control the seas.

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[1] *Hawaiian Planters' Record*, 1940, 44, p. 19.

Agricultural Progress in British Guiana.

"That is a good report," a friend once remarked as he balanced a somewhat bulky official document in his hand, feeling the weight, without opening the cover. This remark is quoted as it has its application to reviews of such literature. Most reviewers probably feel that some relation should exist between the length of a review and the importance of the context or, at least, that his readers will subconsciously draw such an association. But the matter is not so simple. Reports are of two kinds; one, by the novelty of the ideas developed, may be worthy of extended review though characterized by brevity. The other is represented by an interim report showing the progressive steps in a concerted attack on a particular problem. The one may appeal, owing to the novelty of the ideas, to the general public; the other only to the limited public interested in the particular subject.

These reflections have come to the mind with the successive numbers of the reports of which that now to be passed under review is the latest.[1] It is a report of the latter kind; a progress report dealing with investigations of great local importance of which, however, the basic problem and the general lines of approach to that problem have been laid down (and reviewed) in previous reports during a number of years. It is essentially a case where, if repetition is to be avoided, a review can not be taken as a measure either of the intrinsic value to the community primarily concerned or of the industry of the investigators. To gain an insight into the scheme of the investigations recorded, a study of previous reviews is indicated.

The Report follows the lines of previous reports and falls into the two major natural sections based on the accepted methods for securing an increased return of sugar—variety and manurial trials. The former fall into three sections according to whether the trials cover plant canes only, two crops, or three or more crops, and thus gradually bring into the picture new canes as these become available; the latter deal separately with the effects of fertilizers supplying nitrogen, phosphorus, potassium, calcium and manganese on the major soil divisions found in the territory, and a concluding section summarizes the present position of the industry in these two respects. The main feature of the season as influencing the results was a very severe and prolonged drought from October to April; in fact, in none of the twelve months July to June did the rainfall reach the average for the corresponding month (1921/1939), and the annual deficit for the year was no less than 46·3 in. (48·05 in. against the average 94·35 in.).

Variety Trials.

In all, these trials number 39 and were conducted largely on plantation lands. Those in which crops up to second ratoons were included naturally contain the earlier raised and more nearly fully tested varieties. In these tests the standard for comparison was POJ 2878. The more promising varieties as indicated by those tests are:—

D 419/33 (Co 281 × Diamond 10).—The number of tests (three plant, two first ratoon and one second ratoon crops) is, perhaps, few; but throughout both tonnage and quality have been highly satisfactory. Nurseries are being established for its propagation. The average of the station yields in all cases exceeds those of the standard, the sum of the three crops is 32 per cent. above the standard.

Co 213.—This cane has been fully tested and has given 4 per cent. more than POJ 2878. But it is as ratoons that it has the superiority and it is probable that this superiority will become more marked in a four or five crop cycle. It is ready for extensive commercial trials.

D 49/30 (D 625).—This cane is fully tested and over the whole Colony equals Diamond 10 (97·3 per cent. on the standard). In certain areas, however, it is superior to Diamond 10 and it is of high quality. All the above figures, as well as the succeeding, refer to yield of sucrose.

Of the trials in which two crops only have been reaped, the most promising canes are:—

D 552/33 (D 219/30 × Diamond 10).—This cane has yielded 23·7 per cent. more than the standard in spite of a poorer juice.

D 166/34 (POJ 2878 × Sorghum).—This cane has yielded heavy tonnages with good quality juice. Its superiority of 9·19 per cent. results from the plant crop. It has reached the nursery stage and is here reported as very encouraging. Multiplication in nurseries is being pushed ahead.

In the trials of plant canes only, five varieties surpassed the standard, but, in all cases, the trial was limited to a single experiment. Of these five two appear especially promising:—

D 169/34.—This cane heads the list with 31·67 per cent. increase on the standard. Co 419, a thick cane which has shown high field merit in the Station's nurseries, exceeded the standard by 13·55 per cent. It is closely followed by D 70/34 (increase 12·15 per cent.).

These figures are based on the sum of all experiments. It does not follow that they are a real indication of the value of the various varieties to the Colony. The soil characteristics vary markedly from region to region, and, with the well-known partiality of varieties for different types of soil, there can be little doubt that the ultimate solution of the problem of maximum production will be found in a number of varieties. Already indications of this are to be found in the Report. With the progress of the experiments this regional localization of varieties is likely to assume a growing importance.

[1] *British Guiana Dept. Agric.; Sugar Bull.* 9; *Field Expts. with Sugar Cane* 9; *The Variety and Fertilizer Position of the Sugar Industry* 6, 1940.

MANURIAL TRIALS.

That variety trials have an interest not limited to the particular country in which they are made is sufficiently indicated by the frequency with which varieties produced in one country have been transported to other countries and there introduced into commercial cultivation. Many instances could be mentioned, and in POJ 2878 and several of the Co varieties examples are to be found in the Report under review. Manurial trials do not, generally, have the same extended interest; the peculiar combination of climate and soil is a very local phenomenon. In particular are the soil conditions of British Guiana almost unique. The broad outline of the manurial problem has been defined in earlier Reports. and the present Report is concerned mainly with the filling in of the less spectacular detail. The subject will be dismissed, therefore, comparatively briefly.

The general effect of sulphate of ammonia as a source of nitrogen is an adverse one on the sucrose content, a decline in quality, however, which does not offset the increase in tonnage. On front land 2 cwt. for plant canes and 4 cwt. for ratoons was recommended. It appears, however, that larger applications are, in some cases, profitable. This applies particularly to the ratoon application which, at pre-war prices, may be raised to 5 cwt. with profit. Local conditions determine the optimum dose which, again, may vary with the changes of price under war conditions. For pegassy clay applications of 6 cwt. accompanied by a ton of limestone to offset the acidifying effects is confirmed as the optimum. Results with nitrochalk, nicifos and nitrate of soda approximate closely with those of sulphate of ammonia when applied at their nitrogen equivalents.

Nearly all the trials with phosphates showed no response; in some cases even deterioration in the quality of the cane resulted. The same remark applies to dressings of both potash and lime, though in the case of potash, the response, if any, was generally beneficial. In one case with lime a response of 3·72 tons cane was obtained.

The concluding section gives a survey of the varietal and fertilizer positions of the industry. POJ 2878 occupies 57·6 per cent. of the total area and Diamond 10 37·1 per cent., the latter thus showing a decline from its peak in 1939 (43·5 per cent.). D 625 has dropped from 62·5 per cent. in 1934 to 2·8 per cent. of the area under cane.

H. M. L.

The Storage of Raw Sugar.[1]

By J. H. WEBSTER, Racecourse Co-operative Sugar Mill, Queensland.

THE HYGROSCOPICITY OF RAW SUGAR.

As raw sugars are known to be hygroscopic, it is probable that the psychrometric conditions of the atmosphere in contact with the crystals may be largely responsible for such behaviour. Accordingly, some 24 sugars from all Queensland districts were exposed to atmospheres of definite humidities and temperatures in order to observe the manner in which the moisture content was influenced.

Experimental Procedure.—The test samples of sugar (approx. 5 grms.) were distributed uniformly over the bottoms of small aluminium dishes, which were placed in large desiccators containing sulphuric acid of concentrations corresponding to three different relative humidities (43·25 per cent. H_2SO_4 = 50 per cent. r.h.; 37·58 = 61·7; and 27·5 = 78·0). The lids of the desiccators were sealed, and the whole completely immersed in an agitated, thermostatically controlled water-bath.

Using the temperatures 31, 35 and 40°C., equilibrium was reached in some 60 hours, but an additional time of 12 hours was allowed as a safety margin. At the completion of each period, the sample dishes were removed from the desiccators, and, after tightly fitting their lids, were weighed to the nearest mgrm. at room temperature. The same samples were used throughout the complete series of tests, and the experiments proceeded in the direction of increasing humidity.

Finally, the test samples were dried and weighed, and the dry weight compared with the original value to determine whether any loss had occurred due to deterioration. In several instances marked losses were found. All samples were analysed for polarization, moisture, ash and reducing sugar, other organic matter (o.o.m.) being found by difference.

Discussion of Results.—In general, all the sugars exhibited similar behaviour, the moisture content increasing with both humidity and temperature, but the changes were not of the same order. Some showed relatively small increases, but with others the moisture increases were rapid. Sugars in the latter class all had high reducing sugar content, the results being therefore tabulated on this basis (see Table I), the moisture values being expressed as a percentage on dry substance. It is there clearly seen that reducing sugar has a very large influence on the hygroscopic properties of sugars.

[1] Part of *Technical Communication No. 5, Bureau of Sugar Experiment Stations, Brisbane.*

Analytical data were examined statistically; polarization, ash and colloids correlated with moisture showed no significant relationship; but reducing sugar and o.o.m. a very significant one. It was clear that the organic non-sucrose content of the raw sugar governs equilibrium moisture content in contact with air of a given relative humidity, reducing sugar being by far the most important individual constituent. To illustrate the combined influence of humidity, temperature and reducing sugar on the moisture content of the raw sugars, the results of the tests on the 24 samples are grouped into four classes according to reducing sugar content, the averaged results for each group being given in Table II.

TABLE I.

EQUILIBRIUM MOISTURE CONTENTS OF SUGARS AT DIFFERENT RELATIVE HUMIDITIES AND TEMPERATURES.

Original Grade.	Moist.	Per cent. R.S.	50 per cent. Humidity. 31°C.	35°C.	40°C.	61·7 per cent. Humidity. 31°C.	35°C.	40°C.	78 per cent. Humidity. 31°C.	35°C.	40°C.
A	0·47	0·03	0·46	0·51	0·61	0·75	0·78	0·85	1·60	2·33	2·62
AB	0·30	0·13	0·30	0·32	0·34	0·48	0·51	0·63	1·12	1·65	2·01
B	0·22	0·15	0·18	0·24	0·26	0·38	0·48	0·71	0·81	1·02	1·04
A	0·22	0·16	0·28	0·28	0·31	0·53	0·60	0·67	1·45	2·12	2·94
B	0·48	0·17	0·62	0·63	0·69	0·82	0·87	1·00	2·02	3·13	3·62
B	0·28	0·18	0·30	0·32	0·35	0·62	0·65	0·77	1·56	2·61	3·11
A	0·35	0·19	0·32	0·37	0·42	0·50	0·53	0·58	0·93	1·16	1·46
AB	0·35	0·20	0·33	0·38	0·43	0·53	0·53	0·64	0·84	1·08	1·15
B	0·30	0·20	0·31	0·33	0·34	0·58	0·67	0·79	1·15	1·26	1·46
A	0·56	0·22	0·53	0·58	0·63	0·84	0·89	1·07	1·41	1·68	1·94
AB	0·18	0·22	0·16	0·20	0·29	0·52	0·55	0·62	1·02	1·53	2·42
A	0·43	0·24	0·77	0·82	0·86	1·06	1·20	1·25	1·60	1·86	2·03
A	0·44	0·25	0·40	0·44	0·49	0·53	0·62	0·64	1·18	1·40	1·58
B	0·41	0·26	0·40	0·43	0·56	0·82	0·83	0·90	1·95	2·82	3·42
AB	0·41	0·28	0·35	0·40	0·50	0·76	0·82	0·87	1·37	1·66	1·80
B	0·34	0·30	0·28	0·35	0·36	0·48	0·49	0·52	0·92	1·06	1·21
A	0·36	0·32	0·43	0·45	0·48	0·75	0·75	0·93	1·80	2·90	3·91
B	0·38	0·68	0·34	0·43	0·52	1·27	1·32	2·00	2·38	3·39	4·70
A	0·35	0·73	0·40	0·51	0·72	1·35	1·35	1·65	2·73	3·95	6·14
AB	0·72	0·78	0·50	0·52	0·61	0·96	1·33	1·35	1·95	2·29	3·88
AB	0·53	1·06	0·61	0·66	0·95	2·18	2·18	3·00	4·60	6·18	8·79
B	0·91	1·16	1·15	1·22	1·69	3·02	3·05	4·00	5·31	7·07	8·83
B	1·40	1·44	1·20	1·10	1·27	2·52	2·62	3·00	3·57	3·90	5·45
B	0·84	1·75	1·05	1·20	1·50	3·15	3·15	4·00	6·72	11·85	15·77

TABLE II.

AVERAGED MOISTURE CONTENT OF SUGARS AT DIFFERENT HUMIDITIES, TEMPERATURES AND REDUCING SUGAR CONTENT.

Group.	Reduced Sugar per cent. Range.	Average.	50 per cent. Humidity. 31°C.	35°C.	40°C.	61·7 per cent Humidity. 31°C.	35°C.	40°C.	78 per cent. Humidity. 31°C.	35°C.	40°C.
I	0·03 to 0·20	0·16	0·33	0·36	0·39	0·55	0·61	0·72	1·24	1·75	2·10
II	0·22 to 0·32	0·24	0·42	0·46	0·53	0·72	0·77	0·85	1·43	1·91	2·33
III	0·68 to 0·78	0·73	0·42	0·49	0·62	1·19	1·33	1·67	2·35	3·21	4·91
IV	1·06 to 1·75	1·35	1·00	1·04	1·35	2·72	2·75	3·50	5·05	7·25	9·71

In Fig. 1 the moisture content of the sugars in each group has been plotted against relative humidity for the three temperatures, giving a very striking illustration of the rapidity with which moisture increases with humidity and temperature when the reducing sugar content is high. With low values of this constituent the change is but small.

When a sugar is in equilibrium with the surrounding atmosphere, the vapour pressure exerted by the moisture in the molasses film on the crystals is equal to the partial pressure of the water vapour in the atmosphere. At first sight it might be thought that for a given sugar the moisture content would be constant for a given vapour pressure, independent of temperature. This is not the case, as the equilibrium moisture at a given vapour pressure is a function of temperature (or relative humidity, since, for a given vapour pressure, temperature fixes the humidity and *vice versa*).

This behaviour is simply explained by the fact that the moisture in the sugar film exists as part of a solution and not in the free state. Now the higher the relative humidity, the lower is the temperature for a given partial pressure of water vapour, and hence the lower is the temperature of the liquid film in equilibrium with it. Thus, in order that the vapour pressure of the film at the lower temperature may equal the partial pressure, it follows that the concentration of the film must be reduced, i.e., the moisture content is increased.

Deterioration of Sugar.

Of the sugars examined, several had definitely deteriorated to a certain extent prior to the commencement of the tests, although the dilution indicators were not excessively high; it is very probable that when originally placed in the tins they

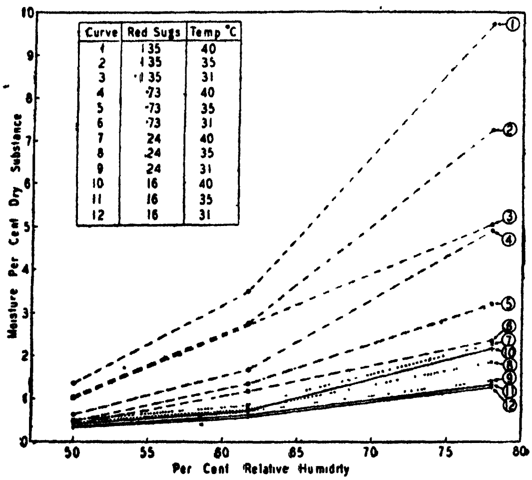

Fig. 1.

had high D.I. values. Decomposition had proceeded, but with the consequent reduction in polarization the values of the D.I. were sufficiently low when the tins were opened to be regarded as safe. In the course of the equilibrium tests, the samples of these sugars had lost a considerable proportion of their dry weight, as indicated by the results in Table III.

Table III.

Compositions of Sugars which Deteriorated during Tests.

Original Values. Moisture.	Reducing Sugars.	Dilution Indicator.	Per cent. loss of Dry Substance.	Original Signs of Deterioration.
1·40	1·44	42·8	5·4	Very evident
0·84	1·75	31·0	3·9	Very evident
0·72	0·78	40·1	2·6	Evident
0·91	1·16	37·3	2·2	Evident
0·53	1·06	24·1	Nil	Nil

The sugars represented in this table had the highest reducing sugar content, and it is interesting to note that the one with the lowest moisture content showed no deterioration. None of the other sugars deteriorated, and all had relatively low moisture contents, and so comparatively low values for the D.I. The bulk samples of the sugars were kept in the closed tins after the small samples for the equilibrium tests had been withdrawn. Those which had shown signs of deterioration were again analysed for pol. and moisture 10 weeks after the original analyses were made, the results showing the composition of the bulk samples had changed slightly.

The extent of this deterioration was considerably less than that which must have occurred in the test samples. This relative behaviour suggests that the storage of sugar in sealed containers will confine the deterioration within certain limits, whereas exposure of the sugar to conditions whereby moisture may be absorbed will lead eventually to complete destruction of the sugar. This phenomenon was noted by Browne[1] who found that at the point of automatic cessation of deterioration the sugars had factors fo safety of approximately 0·25 (D.I., 33·3).

The explanation put forward by Browne, and endorsed by Owen,[2] lies rather in the reduction of the sucrose content of the molasses film than in the auto-intoxication of the micro-organisms involved. A careful examination of these sugars after the abovementioned analyses had been made revealed the almost entire absence of organisms, suggesting that any which had been present originally had failed to survive the conditions developed within the storage tins. Whatever be the explanation, there still remains the fact that the storage of sugar under sealed conditions limits the degree of deterioration possible, and so is a matter of considerable importance.

Conditions for Storage.

On plotting r.h. figures against D.I. values corresponding to several of the average equilibrium moisture contents of the sugars grouped in Table II, it was at once clear that the D.I. varies with both temperature and humidity, and only at the lowest temperatures and humidities employed in the tests did values below 33 occur. These results are contrary to the findings of Thieme,[3] who states that raw sugars with the same D.I. are also in equilibrium with practical ... mgrm. at ... re used throu h.

From the expe obtained in this investigation, it is seen that a satisfactory initial D.I. is no guarantee that sugar will not deteriorate during storage. The satisfactory value must be maintained throughout the entire storage period, and to achieve this certain important factors must receive due attention. Where reducing contents are high and hot humid weather is experienced more rigid control is necessary than elsewhere.

Briefly, the solution of the problem appears to lie simply in the maintenance of low humidity and temperature conditions in contact with the sugar, in other words, warehouses should be maintained dry and cool. Installation of air-conditioning plants calls for considerable financial outlay, both in initial and in running costs. Fortunately satisfactory conditions may be achieved automatically in practice by: (1) providing sealed storage conditions, and (2) by controlling operations during the drying and bagging stages to yield a cool sugar of low D.I. When such a sugar is stored in a closed room, the atmosphere

1 *La. Planter*, 54, p. 281. 2 *Louisiana Bulletin* No. 162. 3 *Archief*, 1934, I, p 157; *I.S.J.*, 1934,. . p. 192.

will gradually come to equilibrium with the moisture in the sugar.

Provided that the volume of air in the room is not large in relation to the quantity of sugar stored this adjustment of conditions will cause very little alteration in the moisture content of the sugar, even though a large change in humidity is involved. For example, 1 ton of sugar can reduce the r.h. of 630 cub. ft. of air at 90°F. from 90 to 40 per cent. for an increase of only 0·01 per cent. in the moisture content of the sugar. Since 1 ton of sugar occupies a volume of approximately 40 cub. ft., of which some 17 cub. ft. is represented by air-filled voids, it follows that provided at least 5 to 6 per cent. of the volume of the storage space is occupied by sugar and that moist atmosphere may not enter, the humidity of the atmosphere in the room will come to equilibrium with the sugar without appreciable change in the moisture content of the sugar. This fact is fully appreciated in tropical countries as Java[1] and the Philippines,[2] where sugar has been successfully stored in sealed warehouses over very long periods.

In considering such a requirement, one naturally asks: Would not moisture impervious containers prove the best solution to the problem? The answer is an emphatic affirmative, provided that such containers could be obtained economically. Obviously the use of paper sacks would introduce handling difficulties, and for this reason smaller sacks would probably be necessary. GEERLIGS[3] carried out a series of tests in which rubberized paper liners were fitted to ordinary sacks, but found these to afford no protection to the sugar. Apparently the water-proofing medium was not satisfactory, or else the method of closing the sacks was not proof against the ingress of moisture to the sugar.

There is little doubt, however, that satisfactory materials could be found, but their cost would certainly be greater than that of the present bags. This extra cost would prohibit their use; e.g., 1d. per bag for an output of 24,000 tons per year would be £1,400. When this sum is compared with that required to recondition the present sugar room or even to build entirely new ones it is clear that the main obstacles in the way of impervious containers are economic ones.

It appears, therefore, that the most satisfactory measures to adopt are those directed to the correction of the faults in the present sugar stores, and in this respect the requirements enumerated by the Philippine Committee[4] may be considered as ideal. One of these requirements states that the stores should be maintained warm, whereas the results of this investigation point to low temperatures as being more satisfactory.

This apparent anomaly is readily explained by the fact that when during the night temperatures fall considerably the dew point may be reached in the atmosphere in contact with the roof inside the store, resulting in condensation and possible damage to the sugar as the result of drips. Therefore the minimum temperature in the store should be maintained higher than the dew point of the atmosphere in the store. In other words, during the night a temperature from 70 to 80°F. should be maintained. Alternatively, an insulated lining to the roof of the store should be provided, so as to prevent the atmosphere of the store coming in contact with the cold roof and so eliminate condensation. If such precautions were taken, it is felt that losses through deterioration in storage would almost entirely disappear.

Hardening of Sugar.—Under certain conditions raw sugar may set in the bags to a solid mass, and so cause handling difficulties resulting in monetary loss. Investigators of this phenomenon conclude[5] that any raw sugar will harden if exposed to certain conditions, i.e., hardening is not an inherent feature of the sugar, but the result of a combination of circumstances. HOLVEN[6] probably gives the correct explanation when he states that the molasses film surrounding the crystals is a saturated solution, which sets on cooling or evaporation, and so cements the crystals together.

New Absolute Alcohol Process.

[1] *I.S.J.*, 1919, p. 543. [2] *I.S.J.*, 1932, p. 29.
[3] "Cane Sugar and its Manufacture." H. C. PRINSEN GEERLIGS. (Norman Rodger, London). 1924. Page 281.
[4] *I.S.J.*, 1932, p. 29. [5] *Reports of the Association of Hawaiian Sugar Technologists*, 1929, p. 1.
[6] *Hawaiian Planters' Record*, 1929, p. 523.

The Solubility of Sucrose.[1]

By G. VERHAAR.

Early Work.—The first data to be properly worked out came from SCHEIBLER[2] in 1872, who from results found experimentally at 0, 14 and 40°C. compiled the following table :—

TABLE 1.

Temp. °C.	Sucrose, grams per 100 of solution.	Temp. °C.	Sucrose, grams per 100 of solution.
0	65·0	30	69·8
10	65·6	40	75·8
20	67·0	50	82·7

Though sub-saturated solutions were used, these values were later found to be too high. Later, FLOURENS[3] also carried out determinations using nearly the same method as SCHEIBLER, but above 20°C. his results (see Table 8) are much lower.

Herzfeld's Investigations.—Emphasizing that the technique of previous workers was not to be recommended, HERZFELD in 1892 published the results of his very thorough determinations.[4] He pointed out that continuous stirring of the liquid, and the presence of an excess of crystals, were both necessary in order to reach the state of equilibrium. After being dried at 105°C. the refined sugar used had a polarization of 100·0°C.

He approached the state of equilibrium at a certain temperature by the use of either sub-saturated or a supersaturated solution. In the table below are summarized the values thus found experimentally, the last column giving the time during which the solution had been stirred at constant temperature to attain equilibrium.

TABLE 2.

Temp. °C.	Sucrose, grms. per 100 of Solution.	Equilibrium reached from :	Time.
5·20	66·17	Supersaturation	2 hr. 45 min.
19·15	66·65	Subsaturation	2 hr. 25 min.
28·80	68·31	Supersaturation	1 hr. 10 min.
49·53	72·23	Supersaturation	1 hr. 45 min.
59·40	74·33	Subsaturation	2 hr. 0 min.
99·45	82·76	Subsaturation	2 hr. 0 min.

It is strange that later, when others called HERZFELD'S results into question, none directed attention to the time factor, whereas it is now known (and in fact appears from the writer's own experiments) that sucrose solutions pass very slowly into equilibrium from the supersaturated state.

Using the above values, HERZFELD compiled his well-known table by the interpolation of values from 0 to 100°C., the formula calculated according to the method of least squares which expressed this solubility being the following :—

$$S = 64{\cdot}1835 + 0{\cdot}13477t + 0{\cdot}0005307t^2$$

On comparing values thus calculated from those actually found, the following differences are to be seen :—

TABLE 3.

Temp. °C.	Found.	Calculated.	Difference.
5·20	65·17	64·90	—0·27
19·15	66·65	66·95	+0·30
28·80	68·31	68·50	+0·19
49·53	72·23	72·16	—0·07
59·40	74·33	74·06	—0·27
99·45	82·76	82·84	+0·08

Interpolation Formulae.—Later investigators have thrown doubt on the accuracy of this interpolation formula. Thus, HORSIN-DÉON,[5] 10 years later, proposed an equation of quite another character to express the connexion between sucrose solubility and absolute temperature :—

$$x = \frac{y}{5} + \sqrt{\frac{y}{5}}$$

which attractively simple equation was subjected to a close examination by SCOTT-MACFIE,[6] who proposed a yet simpler equation, viz. :—

$$x = 0{\cdot}2125y + 3{\cdot}99.$$

However, although these equations give practically the same values, the differences between their results and the figures of the Herzfeld table are so considerable that neither of them can be regarded as an accurate expression of the solubility of sucrose. Moreover, these differences vary between one another (at least up to 80°C.), by from —2·18 to +0·64.

Orth's Formula.—ORTH[7] proceeded to compile a formula, but in a different way. He had noticed that the water content per 100 of sugar changed almost proportionally to the temperature, the basis of the calculation being the following figures from Herzfeld's results, in which S = the weight of sugar in 100 grms. of the solution and E = the water content per 100 of sugar :—

TABLE 4.

Temp. °C. :	5·2°	19·15°	28·8°	49·53°	59·4°	99·45°
S	65·170	66·650	68·310	72·230	74·330	82·760
E	53·445	50·038	46·391	38·447	34·535	20·831

Assuming that the water content E increases in proportion to the fall of the temperature, then we can write : $E = a\,(b - T)$, in which a and b are constants. By application of the method of least squares, one obtains the following values for a and b :—

$$E = 0{\cdot}35509\,(157{\cdot}97 - T).$$

In order to examine the agreement of this equation with the actual figures, we substitute the values for

1 Abridged from the *Archief*, 1940, 1, pp. 325-334, this article being part of a student's thesis to be published later in full. Refer also to *I.S.J.*, 1940, pp. 21-24. 2 *Berichte*, 1872, 5, p. 343. 3 *Compes rendus*, 1876, 83, p. 150.
4 *Zeitsch. ver. Rübenz.*, 1892, 42, p. 181. 5 *J. des fabr. de sucre*, September, 1902. 6 *La Sucrerie belge*, 1906, 35, p. 283.
7 *Bull. Assoc. Chim. Sucr. Dist.*, 1918, p. 94.

T of the tests in the above equation, and calculate S from :—

$$S = \frac{10{,}000}{100 + E}$$

In the following table the results are given against I; against II are the direct results of the determinations; and against III appear the values obtained by Herzfeld's empyrical formula :—

TABLE 5.

Temp. °C.:	5·2°	19·15°	28·8°	49·53°	59·4°	99·45°
I ..	64·83	66·98	68·56	72·20	74·07	82·80
II ..	65·17	66·65	68·31	72·33	74·33	82·76
III ..	64·90	66·96	68·50	72·16	74·06	82·83

Comparison of the results obtained by the formula with the figures of Herzfeld's solubility table make the agreement more striking, thus :—

TABLE 6.

Temp. °C.	Sucrose per 100 of Solution. Calculated.	Sucrose per 100 of Solution. Herzfeld.	Sucrose per 100 of Water. Calculated.	Sucrose per 100 of Water. Herzfeld.
0	64·06	64·18	178·3	179·2
20	67·12	67·09	204·1	203·9
40	70·48	70·42	238·7	238·1
60	74·19	74·18	287·5	287·3
80	78·32	78·36	361·2	362·1
100	82·93	82·97	485·8	487·2

Therefore, the deviations are of no importance, and the equation gives results agreeing both with the actual determinations and with Herzfeld's interpolation formula. S = the quantity of sugar per 100 of water (can easily be calculated from the above equation), E being still the grms. of water per 100 of sugar, and s = the grms. of sucrose per 100 of solution :—

$$\text{Then } E = \frac{100 - S}{s} \times 100\text{; and } S = \frac{10{,}000}{0{\cdot}35509} \times \frac{1}{157{\cdot}97 - t} = \frac{28{,}162}{157{\cdot}97 - t}$$

Thus, Herzfeld's interpolation formula is now represented by a simpler equation, expressing the solubility equally well. As appears from Table 5 above, the differences are practically equal, and cannot apparently be ascribed to experimental error. If one assumes the accuracy of a solubility determination to be 0·1 per cent., which should easily be attained, then the differences would amount to 0·1 at most. But the differences in Table 5 are considerably greater than this. Orth's formula can therefore be regarded as an improvement on those previously proposed.

Later Determinations.—GRUBE and NUSZBAUM[1] in 1928 published a communication on the sucrose-water-SrO system, in which appeared the results of new experiments on the solubility of sucrose, their results being in good agreement with Herzfeld's values, which are given in the column headed H.

TABLE 7.

Temp. °C.	Sucrose per cent. per 100 Water.	H.	Temp. °C.	Sucrose per cent. per 100 Water.	H.
0	179·4	179·2	75	339·3	339·9
25	212·3	211·6	90	415·7	415·7
35	227·9	228·4	95	448·2	448·2
50	260·3	260·4	100	487·0	487·2

Then GRUT[2] in his determinations found a good agreement with the figures of Herzfeld's table at temperatures up to 60°C., but above that considerable deviations. Recent determinations made, viz., those of D'ORAZI,[3] and HRUBY and KASJANOV,[4] are in the same direction. D'ORAZI was able to confirm Herzfeld's figures up to 50°, but above that found small deviations; HRUBY and KASJANOV carried out determinations at 50 and 80°C., and also found agreement at 50°C., but a rather great difference at 80°C., Herzfeld's results being 78·35 and Hruby and Kasjanov's 78·85 per cent.

Of what importance this difference is for the calculation of the supersaturation coefficient appears from the following example. At 100°C. the ratio of sugar to water according to Herzfeld is 4·86; and according to GRUT it is 5·40. Hence, a sugar solution having a coefficient of 5·0 is sub-saturated by 0·93 according to GRUT, whereas this same solution is supersaturated by 1·03 according to HERZFELD.

In the following table are summarized the principal sugar solubility determinations that have been made so far :—

TABLE 8.

Temp. °C.	SCHEIBLER (1872)	FLOURENS (1876)	HERZFELD (1892)	GRUBE and NUSZBAUM (1928)	GRUT (1937)
0	65·0	64·7	64·18	64·21	—
5	65·2	65·0	64·87	—	—
10	65·6	65·5	65·58	—	—
15	66·1	66·0	66·33	—	—
20	67·0	66·5	67·09	—	66·80
25	68·2	67·2	67·89	67·98	67·68
30	69·8	68·0	68·70	—	68·55
35	72·4	68·8	69·55	69·50	69·50
40	75·8	69·7	70·42	—	70·44
45	79·2	70·8	71·32	—	71·43
50	82·7	71·8	72·25	72·25	72·47
55	—	72·8	73·20	—	73·46
60	—	74·0	74·18	—	74·60
65	—	75·0	75·18	—	75·64
70	—	76·1	76·22	—	76·80
75	—	77·2	77·27	77·24	77·95
80	—	78·3	78·36	—	79·13
85	—	79·5	79·46	—	—
90	—	80·6	80·61	80·61	—
95	—	81·6	81·77	81·76	—
100	—	82·5	82·79	82·96	—

Own Experiments.—In an investigation on the solubility of sucrose in water-acetone mixtures, the author had determined the solubility of sucrose in pure water at 30°C., and in the following three

[1] *Zeitsch. Elektrochem.*, 1928, **34**, p. 91. [2] *Zeitsch. Zuckerind. Czechoslov.*, 1937, **61**, p. 345. [3] *Ind. Sacchar. Ital.*, 1938, **31**, p. 401. [4] *Zeitsch. Zuckerind. Czechoslov.*, 1939, **63**, p. 187; *I.S.J.*, 1940, p. 21.

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ways : (*A*) from sub-saturated solutions with coarse crystals as solid phase ; (*B*) likewise, but using fine crystals ; and (*C*) from super-saturated solutions by cooling.

A description of the method and apparatus used will be given in a forthcoming publication, and only the results obtained will be stated here. The determinations were carried out in triplicate at least, and mutual deviations were never greater than 0·1 per cent. The liquors were maintained in motion in the flasks for a minimum of 20 hours, and the following figures were obtained :—

(*A*)	68·40	sucrose per 100 of the solution.
(*B*)	68·32	
(*C*)	68·72	

From these results one can draw the following conclusions : (1) in reaching equilibrium the size of the crystal is not of importance provided that the liquid is maintained a sufficient time in motion; and (2) at a temperature of 30°C. even after 20 hours' stirring a supersaturated solution will not have reached equilibrium.

Furnace Investigations in Queensland, 1939 Season.[1]

By G. H. JENKINS.

Tests on Bingera Unit.

In 1938 a large boiler economizer unit was installed at Bingera mill, a detailed description of which has been given by Stoward,[2] his principal data being reproduced below. Fig 1 herewith shows the arrangement of furnaces, boiler and economizer. It will be observed that the economizer is of Green's old type with the flue gas traversing the vertical tubes in a single pass without baffling, and that in the furnace separate and conveniently adjustable openings for the admission of top and secondary air are provided.

Principal Dimensions of Bingera Boiler Unit.

Boiler Heating Surface (maker's rating)	8,283 sq. ft.
Grate Area (total of three furnaces)	75 sq. ft.
Ratio of Heating Surface to Grate Surface	110
Furnace and Combustion Volume	2,387 cub. ft.
Heating Surface of Economizer (maker's rating)	6,656 sq. ft.
Ditto (tubes only)	6,233 sq. ft.
Working Pressure of Boiler (gauge)	230 lbs./sq. in.

Two tests, each of approximately 4 hours' duration, were carried out with this boiler-economizer unit, and the results of the tests are given in the table. During Test 1 the evaporation rate was normal, while Test 2 was made at a considerably higher rating in order to obtain some indication of the variation of efficiency with evaporation rate.

Discussion of Results.—The output of 6·0 lbs. steam per sq. ft. per hour in Test 2 shows that a high rating is obtainable with a total induced draught of 1·5 in. water gauge, which result was confirmed during a visit of the Bureau engineers when an average rating somewhat higher was maintained for nearly 24 hours. The overall efficiency of the unit is high in both tests, the figure of nearly 65 per cent. at the high rating of Test 2 being especially creditable, while at the lower rating in the first test the efficiency is nearly 2 units higher.

	Test No. 1.	Test No. 2.
Heat Balance, complete boiler unit (per cent. gross cal. value)—		
Efficiency	66·82	64·93
Condensation loss	18·09	18·37
Sensible heat loss	7·24	10·29
Unburnt gas loss	1·33	1·84
Unaccounted losses	6·52	4·57
	100·00	100·00
Heat Balance, boiler only (per cent. gross cal. value)—		
Efficiency	61·66	58·94
Condensation loss	18·09	18·37
Sensible heat loss	11·71	15·65
Unburnt gas loss	1·54	2·11
Unaccounted loss	7·00	4·93
	100·00	100·00
Duration of test, hours	4·15	3·97
Evaporation, actual, lbs./sq. ft./hour (maker's rating of H.S.)	4·60	6·02
Boiler gauge pressure, lbs./sq. in.	199	208
Feed-water temp. entering economizer °F.	216	213
Feed-water temp. entering boiler, °F.	293	306
Moisture per cent. steam	—	1·00
Ratio dry steam/bagasse	2·89	2·76
Bagasse :		
Per cent. pol.	1·47	1·39
Per cent. moisture	47·3	47·9
Gross cal. value (B_h), B.T.U./lb.	4,366	4,317
Quality factor, q	0·819	0·816
Combustion rate, lbs./sq. ft. grate area/hour	174	238

1 Extracted from *Technical Communication No. 4 of 1940, Bureau of Sugar Experiment Stations, Brisbane.*
2 *Proc. Queensland Society of Sugar Cane Tech.*, 10th Conf., p. 95.

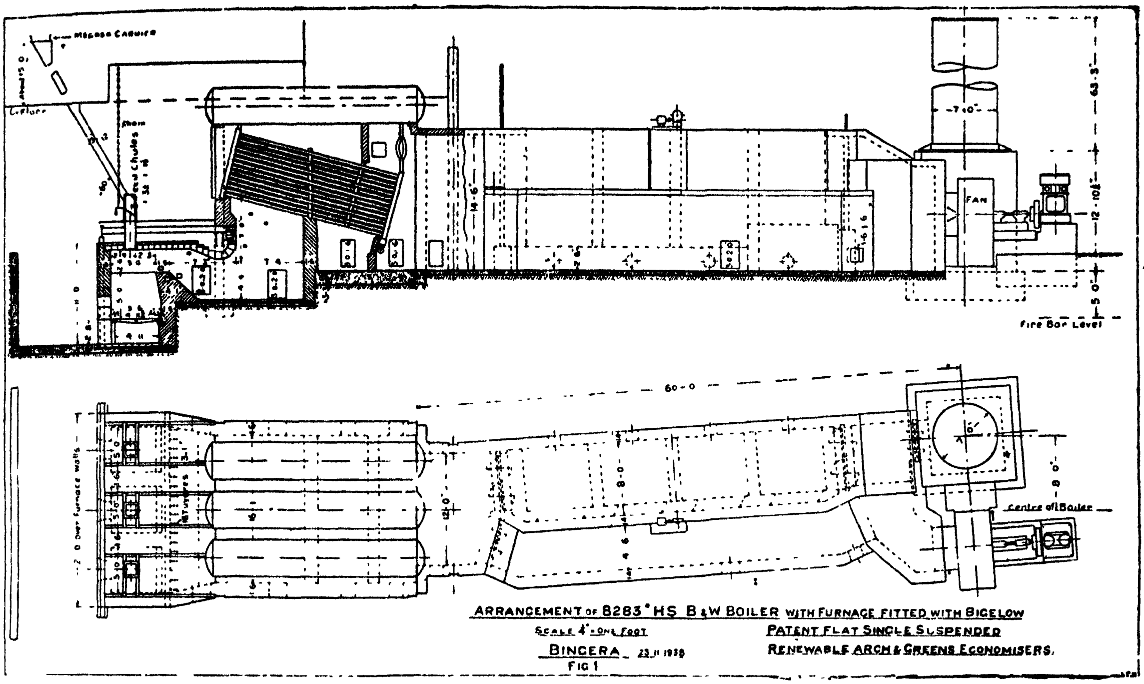


Fig 1.

Flue gas :		
% $CO_2 = m_1$—leaving boiler	16·4	15·9
leaving economizer	12·6	13·7
Unburnt $= m_2$—leaving boiler....	0·6	0·8
leaving economizer	0·4	0·6
% excess air—gas leaving boiler ..	23·6	27·4
gas leaving econ'er	60·5	47·7
Temp. in furnace, °F............	1,450	1,360
Temp. in combustion chamber, °F.	1,720	1,770
Temp. leaving boiler, °F.	461	572
Temp. leaving economizer, °F.	280	377
Economizer performance :		
Heat gained by water in economizer (per cent. gross cal. value)......	5·16	5·99
Heat lost by flue gas in economizer (per cent. gross cal. value)	4·47	5·36
Apparent efficiency of economizer, per cent.	115	112
Heat transmission, B.T.U./sq. ft./hr.	441	697
Heat transfer coefficient, B.T.U./sq. ft./hr./°F....................	4·1	3·3
Draught, inches water :		
Furnace	0·4	0·5
Back of boiler	—	1·0
Outlet from economizer..........	0·9	1·5

Inspection of the heat balance shows that the high efficiency is due to the low sensible heat loss and low unaccounted losses, the former being achieved by good combustion work together with low final temperatures of flue gas. Considerable air leakage is in evidence, as shown by the large difference in flue gas analyses before and after the economizer; and combustion efficiency must be judged by the analyses of the gases leaving the boiler. These figures indicate the low excess air percentages of 24 and 27 per cent. respectively, but also show an appreciable loss in unburnt gas.

Considering the low excess air and the high ratings, especially in Test 2, it is gratifying that the latter loss is so small, since only in one instance in tests by the Bureau has complete combustion been obtained with such low excess air figures. Further, the presence of unburnt gas was indicated only for short intervals totalling perhaps one-quarter of the test period in each case. It must be concluded, however, that even with careful control of the air supply with the aid of the CO_2 recorder, the present arrangement of the furnace and combustion chamber does not guarantee complete combustion at the low excess air percentages used.

The CO_2 percentage was fairly regular in each test. To achieve these results, close regulation of draught and top and secondary air was necessary, and it is possible that with routine control the combustion results obtained would be somewhat inferior. On the other hand, the unfavourable effect of intermittent hand feeding during the tests would to a great extent offset any improvement due to the closer attention given.

The low values of final flue gas temperature are partly due to the air leakage occurring at the economizer. In the absence of such leakage, the

final temperatures would have been approximately 320 and 400°F. respectively for the two tests. These are still low figures. Thus, good heat transfer is indicated in both cases; and the low temperatures of the gases leaving the boiler show that this applies to the boiler as well as to the economizer.

It is possible that the work of the economizer materially assisted heat transfer in the boiler, since, by reducing the sensible heat requirements of the water, the pre-heating of the feed would permit more rapid ebullition, conducive to higher heat transfer coefficients. Such a conclusion is consistent with the findings of the Queensland Committee on Fuel Economy, 1933, who concluded that the efficiency of a boiler is raised by 4 or 5 per cent. by admitting the feed water at steam temperature.

A novel feature of this installation is the provision of a cone or "spreader" of fire cement in each furnace, so placed that the entering bagasse strikes it and is to some extent spread laterally over the grate. Thus the fuel bed is of much more uniform thickness than is usual with a flat-grate. Consequently, combustion takes place over a large proportion of the grate area, and the air velocity through the burning fuel is lower than with the usual conical pile of bagasse.

Besides being conducive to better combustion, this reduces the "fly ash" loss consequent on picking up fine particles of bagasse by high air velocities near the corners of the grate. Another advantage of the spreader cones, according to the chief engineer (Mr. STOWARD) is that, due to the smaller quantity of "green" fuel in the furnace, the time consumed in burning down preparatory to cleaning the fire is less than with the ordinary flat-grate. Hence the reduction of steaming capacity while cleaning is less.

The unaccounted losses of 6·5 and 4·6 per cent. B_h are low in view of the large total surface of uninsulated brickwork exposed to the atmosphere. It must be concluded, therefore, that fly ash losses are small, which is unusual for flat-grate furnaces working at a high rating and burning fine bagasse. Since the rate of combustion per sq. ft. of grate area is much higher than for any other tests conducted by the Bureau on flat-grate furnaces, the absence of high "fly ash" losses must be attributed to the effect of the spreader cones already discussed.

The unaccounted losses are considerably lower in Test 2 than in Test 1, as would be expected from the effect of increased rating on radiation losses. In previous tests on other boilers,[1] with increased rating the unaccounted losses increased, due to much higher fly ash loss. During the present tests, practically no smoke was visible at the stack.

In both tests the unaccounted losses before the economizer are higher than those after it. This may be explained by delayed combustion occurring in the economizer, as suggested by the economizer figures. Such delayed combustion would mean that a portion of the heat which has not been liberated when the gases leave the boiler, and thus appears in unaccounted losses at that point, is recovered in the economizer, thus reducing the final loss.

Economizer Results.—As calculated from the rise in temperature of the feed water, the heat recovered by the economizer was respectively 5·2 and 6·0 per cent. of the gross calorific value of the bagasse for Tests 1 and 2 respectively. These figures show that a substantial heat recovery was obtained by the economizer, in spite of the low initial gas temperatures, the high feed water temperatures and the moderate heating surface of the economizer.

The good heat recovery is due to the high heat transfer coefficients[2] obtained in the economizer, that for Test 1 being greater than any of those for air preheaters in any previous tests, while the coefficient for Test 2 would probably have been still higher if the tubes had not been somewhat dirty on account of working without the scrapers.

As already mentioned, considerable air leakage at the economizer was disclosed, mainly at the holes through which pass the chains actuating the soot scrapers of the economizer. The reduced leakage in Test 2, even with a higher draught, is explained by the fact that, prior to this test, the scrapers were stopped and the openings partially sealed. The air leakage at the scraper chains is of considerable magnitude and, even at that stage of the boiler system, has the undesirable effect of retarding heat transfer to the tubes and increasing sensible heat loss. It appears desirable to adopt some other means for cleaning the tubes, such as soot blowers. Modern gilled-tube types of economizer are specifically designed to keep the tubes clean mainly by using high gas velocities, assisted by the occasional use of soot blowers.

The high figures for apparent efficiency of the economizer suggest that considerable delayed combustion of solid or gaseous fuel occurred in this unit, as has been frequently observed with air heaters. It will also be observed that the unburnt gas loss shows a small but consistent drop between the two sampling points. The smaller quantity of unburnt gas after the economizer is evident—even when due allowance is made for air leakage—from a comparison of the two CO_2 recorder charts. These results and those of the 1938 tests at Kalamia suggest that appreciably delayed combustion can take place in the later stages of the gas path, though there is no obvious fly ash loss at the chimney.

1 *Tech. Comm. No.* 8, *Bur. Sugar Expt. Stations, Brisbane,* 1937.

2 Based on the maker's rating of heating surface, often considerably larger than effective heating surfaces; the maker's figure for the economizer has also been used for the sake of uniformity.

Fuel Alcohol Production.[1]

By G. C. DYMOND.

About 10 years ago the whole question of alcohol as a suitable addition product to gasolene centred around the practical success of processes for converting rectified spirits into anhydrous alcohol, using the Melle, Hiag, Drawinol and other processes, but in the Philippines the 95 to 96 per cent. alcohol (by volume) is denatured with 1 to 5 per cent. of gasolene and used direct. Adjustments required in the engine are stated to be as follows :—

1. Shimming up connecting rod bearings to give increased compression ;
2. Installing metal floats in carburettors, and increasing the size of the jets ; and
3. Altering the fuel pump diaphragm to alcohol resistant material and installing adequate screens on the fuel lines.

It is stated that many modern engines change over to alcohol without any alteration at all. The International Harvester Co. are stated to have produced Hesselmann engines for this purpose, using liquid injection, like a Diesel, and spark ignition. It is also interesting to note that the Medine Sugar Factory in Mauritius runs its transport on such fuel. WADDELL reports that trials with gasolene and rectified alcohol showed that 27 per cent. more alcohol was required per unit of work, but with gasolene at 2s. 1d. per gall. and alcohol at 11d., it was obviously economical.

It would appear, therefore, that there are two schools of thought : one, the production of 99·7 alcohol, and mixing with about 80 per cent. of gasolene under legislation ; the other, the utilization of 90 to 100 per cent. of a lower grade alcohol with adjustments to the engine. It should be noted that the countries in which the latter method is in practice are tropical and not semi-tropical to temperate, as is the case in South Africa.

The Reich System.—A recent contributor to this journal suggested the conversion of selected factories into distilleries. Apart from certain impractical points in such a scheme, reference was made to the Reich process of using an evaporator in place of the main column of the alcohol still, thereby saving steam, while partially concentrating the slop or dunder. Actually this idea was installed at Anaheim, California, eight or ten years ago, but was discontinued almost immediately and has not been worked since.

Dr. REICH, however, at the distillery of the Pennsylvania Sugar Co., is working on a new method, which is of particular interest for several reasons. He dilutes his molasses to about 60° Brix, filters them in centrifugals to remove the calcium sulphate and suspended matter present ; after fermentation the mash is again centrifuged, whereby all the yeast is removed and finds a ready sale ; the clear liquid is next distilled, and finally the slop or dunder is concentrated for disposal.

This process has great merits, as it obviates the serious incrustations so common with sulphited molasses, simplifies concentration, and would ease the recovery of glycerin from the concentrate.

Decentralization.—A study of fuel alcohol production is usually confined to : the Government attitude and its loss of revenue ; and the attitude of the oil companies. In actuality, a sugar-alcohol programme goes far deeper than such simple economic factors. The author refers to non-centralization.

Centralization of alcohol production is simply the concentration of the molasses supply at one or two points and the final limitation of quantity to the amount of molasses available. This project is one of elemental business and needs no further remarks.

Decentralization on the Brazilian model is of so far-reaching a nature that the potentialities are generally overlooked. It means the production of sugar and alcohol *at the sugar factory*, and the obvious benefits are :—

(1) Co-ordination of operations under one organization ; (2) economy in steam ; (3) no railage on molasses ; (4) simplification of sugar production under a quota system ; and (5) the possibilities of producing comparatively large quantities of fuel alcohol from surplus cane (from raw juice, last mill juice, and low-grade products).

Less obvious factors.—In Hawaii, owing to the development of grab harvesting, which has resulted in incredible amounts of mud, roots, trash and tops entering the mills, they have been forced to perfect mechanical cane cleaning devices. Then a survey of suggested methods for slop disposal in Brazil alone illustrates how this problem has exercised the brains of technical men and officials for many years.

There is a link between the Hawaiian cane cleaning devices and dunder disposal, viz., the work of Sir ALBERT HOWARD, and the increasing importance that is being attached to humus. From the cane cleaning devices there is an almost unlimited supply of dry vegetable matter and from the distillery slop, filter-cake and effluents of the sugar factory, there exists an active and valuable composting medium.

The difficulties and costs of composting in the field were summed up by the writer in a paper to the South African Sugar Technologists' Association : "The trash is in one field ; the dung (if any) is at the stables ; the filter-cake or dunder is at the sugar factory or distillery ; the green material somewhere else, and the water anywhere or nowhere ; while the result may be required in quite a different place."

1 *South African Sugar Journal*, 1940, **24**, pp. 595-599 (here a little abridged).

In the scheme proposed, all these factors are combined at the factory with the result that: (1) The cane (on reasonably flat lands) can be mechanically harvested by one of the simpler types of machines. (2) Tops and trash can be left on to suit the composting programme. (3) The disposal of filter-cake, molasses and effluents is achieved without nuisance, giving a valuable product for soil fertility. (4) The removal of the product would be conducted during the off-crop as filter-cake is disposed of at present. (5) The mills would benefit by cleaner cane, while the growers could send in as much trash as they liked.

Cost Figures.—In order to determine the cost of alcohol production, certain basic data are absolutely necessary, viz.: (1) the quantity to be produced; and (2) the basic price of the raw material (cane and molasses). The reason why costs are frequently "up in the air" is that these fundamentals are not stated.

If molasses only is being considered, then the problem resolves itself simply into the price of the raw material at a standard total sugar content, with a tabulated increase for enrichment. Costs of transport, plant, etc., are calculated, and the cost of production easily determined. This is merely centralization, whether the distillery is located at a convenient sugar factory or not.

When, however, as in the Australian plans, large quantities of alcohol are in view, then before any costs can be determined, both the quantity to be made and the basic price for cane must be agreed upon. It is obvious that as the ratio of cane to molasses increases, so the cost of alcohol per gallon will progressively increase.

The Queensland plan[1] lays down certain fundamentals. An increased planting programme which will yield 400,000 tons of raw sugar material is envisaged, which, at the average price of sugar, is worth £13-15-3 per ton. This means that the price of distillery cane is based on the average price received for home consumption and export values. Further calculations are based on a yield of 140 gallons of alcohol per ton of raw sugar, which figure appears extremely high. Thus:—

	Tons Dextrose.		Theoretical Yield of Alcohol.		Tons Alcohol.
1 ton Sucrose =	1·0526	..	51·1%	..	0·538

At 90% (high) Efficiency. Tons Alcohol.		Gallons of Alcohol.		Conservative Figure used.
0·484	..	121	..	114

In some way the Australian figure may include the yield from ordinary process molasses, thereby bosoting the total yield to 140 gallons.

Production in South Africa.—In this country the production of say 20,000,000 gallons of alcohol would mean that 110,190 tons of raw sugar material would have to be provided in the form of juice:—

	Galls. Alcohol.
Amount available from molasses	7,438,500
To be found from surplus cane	12,561,500
Total....................	20,000,000

At 114 gallons of alcohol per ton of raw sucrose 110,190 tons would be required, which at 92 per cent. extraction represents 119,770 tons of sucrose in cane, or 880,660 tons of cane at 13·6 per cent. sucrose. Based on the Australian method, the average price of sugar divided by the yield gives the cost per gallon in terms of cane, which in Natal would be £10-19-0 ÷ 114 = 1s. 11·1d.

Incidentally, this is practically the same figure as determined in Australia on a basis of £13-15-3 on a yield of 140 gallons. As the cost from molasses only is much lower, say 7d., the combined cost of 20 million gallons would be 1s. 5d. at the present price for cane.

For comparison on this basis, if the value of distillery raw sugar is £8 per ton, then the cost per gallon of alcohol would be 1s. 4·8d., and the combined cost from cane and molasses would be 1s 1·5d per gallon To these figures must be added the cost of manufacture at the sugar factory at 3d. (Australian figure 5d.) and say 2d. for transport and mixing charges, the final figures therefore becoming:

At Standard Cane Price—
- Australian .. .. 2s. 6·6d. per gallon[2]
- Natal .. .. .. 1s. 10d. per gallon

At £8 per ton—
- Natal. raw sucrose: 1s. 6d. per gallon

A better basis of estimation would appear to be as follows. The yield of alcohol per ton of cane is known to range normally from 13 to 14 gallons—dependent on the total sugar content, the extraction and the efficiency. If 13·5 gallons is taken, then the cost of raw material per gallon ranges as follows with extreme cane prices:—

Price per ton of Cane.		Cost per gallon Alcohol.
10s. 0d.	....	8·9d.
13s. 0d.	....	11·55d.

At these figures the cost of cane and molasses for producing 20 million gallons of alcohol becomes:—

Price per ton Cane.		Cost per gallon Alcohol.		Plus 5d. for manufacture, transport and mixing.
10s. 0d.	....	8·19d.	....	1s. 1·2d.
13s. 0d.	....	9·90d.	....	1s. 2·9d.

This method gives a clear view of the effect of the variables, and an easy means of substitution of other figures for any set of conditions. From the foregoing observations, conditions for an extended fuel alcohol programme would appear to be more favourable in South Africa than in Queensland.

[1] *I.S.J.*, 1940, pp. 338-339.

[2] It is unknown whether this includes the yield from ordinary process molasses.

Chemical Reports and Laboratory Methods.

Estimation of Cane to Sugar Ratio. G. S. MOBERLY. *Proc. 14th Congr. South African Sugar Tech. Assoc.*, 1940, pp. 146-148.

Operation of the provisions of national and international agreements may necessitate a periodical estimation of the tonnage of cane which will be required to make the sugar quota. In 1938, C. L. WATERS suggested that the cane to sugar ratio for the season in South Africa might be estimated by averaging the ratios of the 9th, 10th and 11th weeks and then averaging this figure with the ratio for the week ending nearest to the 1st August.[1]

In 1936, FOLLETT-SMITH and J. E. WILLIAMS[2] directed attention to a value which they termed the Demerara Index (D.I.) for obtaining the quality ratio of cane, defining it as the sum of the sucrose per cent. cane and the tons of cane per ton of sugar. This value was also referred to by a Committee of the 1938 Congress of the International Society of Sugar Cane Technologists.[3]

This figure remains fairly constant for any one factory, though it tends to decrease over a series of years as the manufacturing efficiency improves, as figures from 1930 to 1938 show, and it was not very greatly affected by the unusual conditions prevailing in the locust year of 1934. At present, for the South African factories it varies from 21·8 to 22·8.

The variation of the monthly to-date figure from the crop figure has been recorded for nine factories in South Africa for five years, and from these 45 instances the mean variation and the standard variation from the mean have been calculated. From these figures the following formulae have been prepared for the estimation of the D.I. for the whole season at various times during the season, the final figure after the $\pm$ sign representing the probable degree of accuracy at 19 to 1 odds. Then the tons of cane required to make a ton of sugar for the whole season are found by deducting the predicted sucrose per cent. cane from the estimated D.I.

End of July	Index = D.I. + 0·06 $\pm$ 0·32
End of August	Index = D.I. + 0·05 $\pm$ 0·24
End of September ..	Index = D.I. + 0·03 $\pm$ 0·18
End of October	Index = D.I. + 0·01 $\pm$ 0·12
End of November ..	Index = D.I. + 0·01 $\pm$ 0·09

For instance, at the end of October it might be estimated that the sucrose per cent. cane for the whole season will be 13·80; the D.I. to date at the same time is 22·66; the the tons of cane required to make a ton of sugar would be:

$$22{\cdot}66 - 0{\cdot}01 \pm 0{\cdot}12 - 13{\cdot}80,$$

that is, it would be expected to be between 8·73 and 8·97.

This is for 96° pol. sugar, a correction being applied for the expected average pol. of sugar produced. If this were 98·5 the conversion ratio would be expected to be between 8·96 and 9·20. If the mean value of 9·08 were taken, the error with a crop of 30,000 tons of sugar would probably not amount to more than 3600 tons of cane. This may sound a lot, but it is probably at least as close as could be estimated by any other means two months before the close of the season.

Determination of Sugars in Chocolate and Confectionery. D. W. GROVER. *Food Manufacture*, 1940, **15**, pp. 202-203 and 211.

Sugars entering into the composition of chocolate and confectionery are sucrose, dextrose, maltose, levulose, lactose and dextrin (the latter strictly not being a sugar), the proportions of which greatly influence the consistency, taste and keeping quality of the goods. So extensive, however, is the literature of the analysis of such products that it is difficult to review it. Only a few selected methods suitable for routine use in the analysis of chocolate, boiled goods, toffees, etc., can be mentioned here.

Chocolate.—Processes for the estimation of sugars in chocolate as described by MACARA and HINTON[4] some years ago appear to have received little attention. They consist of the polarimetric estimation of sucrose with a possible error of $\pm$ 0·2 per cent. on the sample, the chloramine-T estimation of sucrose and lactose with possible errors of $\pm$ 0·12 per cent. and $\pm$ 0·34 per cent. on the sample respectively, and the estimation of sucrose and lactose by means of the volumetric Fehling's process (Lane and Eynon) giving an accuracy of $\pm$ 0·33 per cent. and $\pm$ 0·2 per cent. on the sample respectively.

These methods have proved reliable, and data are given for obtaining the most accurate results possible by means of corrections for the effects of cocoa material, etc. Probably the most useful combination of methods is to determine the sucrose polarimetrically and the lactose by copper reduction; the presence of dextrose would then become evident, and the amount present could be approximately calculated. It must be borne in mind that other determinations, e.g., of calcium, casein, etc., throw useful light on the sugar analysis and help in its interpretation.

Boiled Goods.—These consist mainly of sucrose, invert sugar and glucose. Sucrose may be estimated directly from the polarization; invert sugar by means of the levulose determination; and the glucose then calculated from the direct polarization and from the method of polarizing at a temperature of 87°C., at which degree the + of the dextrose is neutralized by the — of the levulose rotation.

1 *Proc. 12th Congr South African Sugar Tech. Assoc.*, 1938, p. 63. 2 *I.S.J.*, 1937, p. 281. 3 *I.S.J.*, 1939, p. 186.
4 *Analyst*, 1931, **56**, p. 286; *Confectionery Jl.*, 1930, pp. 241, 313, 357, 407.

Toffees.—Toffee containing milk solids may conveniently be clarified by means of the zinc acetate, potassium ferrocyanide reagents.[1] As most of the casein has already been rendered insoluble by the cooking process, only small amounts of the reagents are required; 20 grms. of sample are dissolved in tepid water, diluted to about 150 c.c., 5 c.c. of the zinc acetate solution added, followed by 5 c.c. of the potassium ferrocyanide solution. The solution is made up to 200 c.c., shaken, and after 10 minutes, filtered.

The analysis is the same as for boiled goods, except that lactose will be present. For the estimation of the levulose take 10 c.c. of the 10 per cent. solution. Sufficient data are then obtained for the calculation of the lactose and the glucose, provided that the reducing power and specific rotation of the latter are known. In the case of other confectionery products, the methods already stated can be applied, but the clarification of the solutions has to be worked out for each separate sample, and difficulty may sometimes be experienced in obtaining a sufficiently clear solution for polarization. Recourse may have to be had to other, less accurate means of determiningthe sucrose.

Report on the Determination of Ash in Molasses. R. A. Osborn.[2] *Journal of the A.O.A.C.*, 1940, **23**, pp. 567-572.

Methods for the determination of ash in sugars and sugar products, as described in "Methods of Analysis" of the A.O.A.C. (1935), p. 465, are studied in this Report. It has long been recognized that the weight of ash obtained by treatment by ammonium carbonate followed by heating in a muffle at very dull red heat is for all practical purposes the same as that obtained without the use of the carbonating reagent. Apparently this procedure gives an ash that is no more carbonated than a normal ash obtained without the use of a carbonating reagent. This raises questions regarding the propriety of the term "carbonated ash" and the utility of the carbonating reagent.

Since carbonated ash obtained at "low redness" or "at a very full red heat" as specified in the two methods is indefinite, an ashing temperature of 525°C. was specified. It is apparent that if a carbonated ash is desired, the temperature at which the material should be heated after carbonating should be much lower than 525°C. While the data do not show the optimum temperature for obtaining a full carbonated ash, it is the opinion of the author based on experience that the temperature should be 240 to 270°C. Under such conditions the carbonate ash values are generally from 5 to 10 per cent. higher than the ash values at 525°C.

The author believes that it is preferable to call the determination "ash," to discontinue the use of ammonium carbonate, and to specify a definite ashing temperature of 525°C. A minor change in Method I should be made to correlate Methods I and II; the ash obtained under Method I should invariably be wet down at least once, dried on a steam-bath rather than on a hot plate, and re-ashed at 525°C. in order to assure the complete removal of carbon, traces of carbon not being easily seen or removed by ashing unless this procedure is followed. It appears that at 525°C. the ash is slow in coming to its constant weight. No difficulty was experienced in the determination of sulphate ash at 600°C., and the values from direct determination and by sulphating after first determining the carbonated ash are for practical purposes the same.

In the following table are summarized the results of an experiment designed to ascertain the temperature most suitable for the determination of sulphate ash, using 525, 550 and 600°C. Between successive weighings the ashes were heated for one hour. The data indicate somewhat lower percentages of ash as the temperature increases; constant weight of ash is more quickly obtained at 600°C. than at 550 or 525°C. The author favours 600°C. for the ashing temperature, but further data are required on this point.

	525°C.	550°C.	600°C.
First weighing	11·25	11·19	11·10
Second (reheated 1 hour).	11·19	11·13	11·10
Third ,, ,, ..	11·19	11·07	11·03
Fourth ,, ,, ..	11·15	11·04	—

Report on Sugars and Sugar Products (Copper Equivalent of Levulose by the M. & W. Method). R. F. Jackson. *Journal of the A.O.A.C.*, 1940, **23**, pp. 558-560.

Munson and Walker's table of copper equivalents of reducing sugars has hitherto lacked the values of pure levulose. These equivalents have recently been published by L. D. Hammond as part of a comprehensive revision of the tables.[3] He purified levulose by crystallization from aqueous solution, and subsequent re-crystallization from aqueous alcohol. His procedure followed that of Munson and Walker in detail except that he employed electric instead of gas-flame heating. Later comparative measurements showed that no difference in copper resulted between the two methods of operation. The precipitated copper was determined by electrolysis.

In quite independent experiments R. F. Jackson and Emma J. McDonald determined the levulose copper equivalents by gas-flame heating and thiosulphate determination of copper. The concordance of analytical results is shown in the following table in which the copper in both determinations is taken from the respective formulae derived by the method of least squares. As the tabulated figures show, the agreement in most instances is within 1 part per

[1] *Analyst*, 1930, **55**, p. 111. Other literature to be consulted includes: *Analyst*, 1932, **57**, p. 680; "Methods of Analysis of the A.O.A.C." 1935, p. 332; *Ind. & Eng. Chem.* (anal. ed.), 1938, **10**, p. 669; *Confectionery Production*, 1938, **4**, p. 428.

[2] U.S. Food and Drug Administration, D.C., U.S.A.

[3] *Jl. Research. Nat. Bur. Stand.*, 1940, **24**, p. 579

1,000, the figures express the mgrms. of levulose taken and the mgrms. of copper found by the two independent workers.

Levulose.	L.D.H.	J. & McD.	Difference.
92	168·4	168·1	—0·3
115	208·7	208·5	—0·2
138	248·5	248·3	—0·2
161	287·5	287·5	0
184	326·0	326·0	0
207	363·7	363·9	+0·2
230	400·8	401·3	+0·5

A pronounced tendency in recent years is towards the determination of reducing sugars by micro-analytical methods, using, e.g., the Somogyi procedure, as applied to the determination of sugars in plant materials, a single leaf or the bark of a single plant in some instances sufficing for the analysis. But while the micro-methods serve a very useful purpose, it should be recognized that they lack the precision of the macro-methods. It is judged that a 2 per cent. accuracy is possible with the Somogyi method, whereas under the most favourable conditions the M. & W. method can be conducted with about ten times this precision.

Lastly, the revised electrolytic method for copper was subjected to a searching test by R. F. JACKSON with the co-operation of E. J. MCDONALD and L. D. HAMMOND. Using a sample of highly purified copper, at least 99·99 per cent. pure, 4·5204 grms. of it were dissolved in 150 ml. of 1 : 1 nitric acid, evaporated to dryness, and made to volume in a 499·81 ml. flask, four aliquot portions being analysed by one observer *A*, and another four by the other *B*, with the following results, the Cu actually taken being calculated to be 452·22 mgrms. :—

	A	*B*
	452·30	452·40
	452·25	452·20
	452·45	452·20
	452·20	452·30
Mean :	452·30	452·27

Pulping Bagasse by the Chlorination Method. LILLY GOMEZ and GEMINIANO O. AGUILA. *Natural and Applied Science Bulletin, University of the Philippines*, **7**, pp. 227-231.

This investigation[1] was undertaken to study the chemical composition of the raw material, to discover a cheap and efficient method of pulping, and to study the chemical composition of the pulped material obtained. The bagasse used came from Lopez Central, where POJ 2878 (45·0), Badila (27·0), POJ 2883 (20·0), and other varieties (8·0 per cent.) were milled.

Analysis of the raw material used in the pulping tests about to be described (calculated on the oven-dry sample) was as follows : moisture, 12·11 ; ash, 1·79 ; alpha-hydrolysis,[2] 23·31 ; beta-hydrolysis,[3] 34·68 ; mercerization,[4] 33·73 ; nitration,[5] 28·44 ; acid purification,[6] 1·61 ; Cross and Bevan cellulose,[7] 54·40 ; alpha-cellulose,[8] 75·22 ; beta-cellulose,[9] 13·30 ; gamma-cellulose,[10] 11·16 ; ash in total cellulose, 0·32 ; total fats and waxes, 13·28 ; benzene extract,[11] 9·93 ; alcohol extract,[12] 2·99 ; other extract [13] 0·35 ; pentosans,[14] 14·66 ; furfural,[15] 8·60 ; lignin,[16] 31·76 ; nitrogen,[17] 0·26 ; and protein,[18] 1·60 per cent.

Pulping process used.[19] 100 grms. of the air-dried bagasse were boiled with 2 litres of 1·51 per cent. NaOH for 2 hours at 20 lbs. pressure. After washing with water till alkali-free, the excess water was removed by pressing, and the material subjected to the action of chlorine gas for 2 hours, washed with water, and soaked in 0·5 per cent. NaOH. Again it was pressed, and subjected to the action of chlorine gas for another 2 hours, the colour then changing, showing that all the ligneous tissues had been attacked.

Next the material was washed with water and bleached, after pressing with 2 litres of sodium hypochlorite solution containing 0·02 per cent. of free Cl for 30 min. at room temperature. Finally, it was pressed and treated with 2 litres of 0·5 per cent. HCl for 10 min., the bleached pulp being washed till acid-free and then dried at 70°C. A yield of 37·6 per cent. was obtained.

It was analysed, with the following results (calculated on the oven-dry sample) : moisture, 8·10 ash, 0·42 ; Cross and Bevan cellulose, 90·17 ; alpha-cellulose, 76·39 ; beta-cellulose, 18·69 ; gamma-cellulose, 4·88 ; pentosans, 22·77 ; furfural, 13·37 ; and copper number, 0·2303. Hence, the C. & B. cellulose content of the raw material is fairly high compared to that of other Philippine agricultural waste products, while the alpha-cellulose content is rather low.

The pentosan content of the raw material does not agree well with the results recorded by other workers. Fats and waxes are unexpectedly high, and may be due in part to some oil and grease introduced in the milling process. Chlorination was very satisfactory with its high yield of 37·6, the pulp obtained being very white, soft, and uniform in texture ; but its alpha-cellulose content was rather low, so low in fact that as made by the process described it can hardly be described as a good starting material for the manufacture of rayon and other cellulose products.

1 It was based on the B.Sc. thesis of the second-named author. 2 "Methods of Cellulose Chemistry." CHAS. DORÉE. (D. van Nostrand Co.). 1933. Page 327. 3 4 5 6 7 *Ibid.* 8 "Chemische und physikalische Technologie der Kunstseide" (Leipzig), 1930. Using modified Jentgen method. 9 Using the gravimetric method described in Dorée's book above. 10 By difference. 11 Soxhlet extraction for 6 hours. 12 The same. 13 The same. 14 "Technical Methods of Analysis." R. C. GRIFFIN. (McGraw-Hill Book Co.). 1927. Pages 493-494. 15 *Ibid.* 16 "Determination of Lignin." J. H. ROSE and A. C. HILL. *Paper Pulp Magazine Can.*, 1929, **27**, pp. 541-544. 17 Kjeldahl. 18 Nitrogen × 6·25. 19 U. POMILIO. *Ind. & Eng. Chem.*, 1932, **24**, pp. 1006-1010.

Brevities.

A TIP FOR LAND GRADING.—According to the *Cane Growers' Quarterly Bulletin*,[1] a simple method of grading land for drainage or irrigation, when a surveyor's level is lacking, is to place out in line across the field a number of petrol or kerosine tins suitably spaced. These are first adjusted level on the ground by means of a spirit level and then by sighting along the top edge of the first tin it may readily be ascertained whether the land surface falls away or rises, regularly or irregularly, as evidenced by the corresponding edges of the successive tins.

ST. MADELEINE SUGAR COMPANY.—The Report for the year ended June last of this leading Trinidad sugar company, which was issued at the end of November, states that the production of sugar was again disappointing, amounting to only 34,044 tons, as against 43,889 tons in 1938-39, and comparing with 53,773 tons in 1936-37. The 1939-40 crop was, in fact, the lowest for ten years past. This meagre out-turn was due in the main to adverse weather, and to a lesser extent to froghopper attack, both unfortunately common to the whole island. Very wet weather was experienced during the ploughing season of 1938 which limited tractor ploughing to half the usual programme and resulted in only two-thirds of a normal crop from the plant cane acreage. Farmers' canes also suffered and showed a further heavy drop in tonnage from the previous year. The Profit and Loss account shows a profit for the year of £14,576 (as against £84,696 in 1938-39), which with the balance brought forward of £42,341, makes available £56,917. After transferring £21,000 of this to Taxation Reserve, a balance of £35,917 is left to be carried forward. No dividend is to be paid (as against 5 per cent.). In the previous year £25,000 was placed to reserve for additions and renewals to plant and machinery, but none this year. The expenditure during the year under this heading was £5,199, leaving a balance in reserve of £23,121. All export sugar was sold to the British Government at £11-5-0 per ton c.i.f., which compares with the average in 1938-39 of £11-2-1 and in 1937-38 of £9-19-3. No crop data are published this year in the Report.

DUTCH EAST INDIES REQUIREMENTS.—According to the *Times Trade and Engineering Supplement* it is clear that the Netherlands East Indies having for the most part lost their import trade with continental Europe owing to the war, they must find new sources of supply for at least 38 per cent. of their normal imports. British exporters are accordingly hoping to secure a good share of these diverted requirements. In normal times there is a steady demand on the plantations for machinery replacements and spares. The sugar industry provides a good illustration of the wide field thus covered; there is a demand for such things as flat bar iron, babbit metal, cast copper, driving belts, bolts, belt lacing, nails, wooden screws, rubber valves, asbestos and cord rubber packing, angle and T-pipes, gas pipes, angles and elbows, rail spikes, brushes, pipe cutters, files and various technical instruments—a very comprehensive lot. Machinery for replacements in sugar factories is purchased locally from accredited agents or, if there is no agent, from general importers of machinery. If he is unable to supply from stock the agent cables the order to his principals, who usually ship on delivery against payment terms and confirm the shipment by letter, or cable a quotation on "usual terms," which means that payment is one-third with order, one-third against documents, and one-third on erection.

CENSUS OF SUGAR MANUFACTURE IN HAWAII.—The U.S. Dept. of Commerce recently issued some figures relating to the Hawaiian sugar industry, as part of the Census of Manufactures taken every ten years. The figures relate to the year 1939, but in Hawaii the previous census was in 1919. The following are some of the Hawaiian sugar industry data for 1939, the figures in brackets being the corresponding ones for 1919. Production of cane sugar, raw basis, 977,377 short tons (537,242); number of establishments, 35 (43); salaried employees, 429 (277); wage earners, 4,371 (3,143); salaries paid, $815,481 ($774,785); wages paid, $2,894,420 ($2,027,128). In the 20 years there has thus been an increase of 40·3 per cent. in personnel, 54·9 in salaried employees, and 39·1 in wage earners.

LABOUR CONDITIONS IN B.W.I.—At the last annual meeting of the Antigua Sugar Factory Ltd., Mr. Mark Moody Stuart said that Trades Unions are now established throughout the West Indies and one can look forward to the time when it will be possible to deal with them as a representative body, speaking authoritatively for Labour as a whole and working with the employers to improve conditions. Unfortunately that time has not yet arrived. In most cases the leaders are men without experience in the sugar industry—either as employers or labourers—and completely ignorant of the conditions they seek to better. The movement lacks the traditions of British Trades Unionism, and unless tactful guidance is available, development may easily proceed along lines which neither the Government, nor the Union officials in this country who helped to foster it, would welcome. In Antigua at the beginning of 1940 relations with Labour were strained, but after lengthy negotiations, what might have proved a serious situation was averted, and no trouble was experienced throughout the crop.

ANTIGUA SUGAR FACTORY.—The output of sugar for the 1939-40 crop was only 14,113 tons, as compared with 19,226 tons in 1938-39, a consequence of severe drought during the growing season. Good rains came in the end and during the reaping season, but this seriously affected the quality of the reaped cane, so that it took about 1¼ tons of cane above the average to make 1 ton of sugar. The Profit and Loss account showed a surplus at the credit of shareholders of £8,798 net (against £11,217) which with the balance brought in of £40,802 left £40,601 available. A dividend of 5 per cent. has been paid, absorbing £9,687, and £39,914 carried forward. The principal crop data for the past season (the previous one in brackets) were: Purity of juice, 83·93 (86·50); mill extraction, sucrose, 96·0 (96·12); Total recovery of sucrose, 87·99 (89·35); Tons of cane per ton of sugar 96° pol. 8·58 (7·25); Tons cane harvested, 121,066 (139,430); Tons sugar made, 14,113 (19,226); Sale price of sugar per ton £12-5-11 (£10-8-0). The 1941 cane crop had early promise of being a bumper one, but subsequently unusual dry weather set in, and the crop will now not be so large as anticipated.

[1] Vol. viii, No. 2, p. 49.

Sugar-House Practice.

Steam Balance of a Queensland Sugar Mill. K. S. LENNIE. *Proc. Queensland Soc. Sugar Cane Tech. 11th Conf.*, 1940, pp. 161-183.

At Pleystowe Mill, Queensland, the boiler plant consists of seven multi-tubular boilers of a total h.s. of 16,830 sq. ft. and one Thompson water-tube of 6,800 sq. ft., all operating on induced draught. Steam is generated up to 120 lbs. per sq. in., and reduced to 90 lbs. by two self-acting regulating valves, one on the 8 in. factory main and the other on the 12 in. mill main.

The factory main feeds several pumps, engines, etc. and also supplies make-up to the exhaust main, the amount of which is controlled by an air-relay operated regulator, which maintains the exhaust main at about 9½ lbs. per sq. in. In addition an air-relay cut-off valve is provided so that, should the boiler pressure fall below 90 lbs. per sq. in., the make-up will be automatically cut off, thus giving the boilers the "breathing space" necessary to pick up again.

This latter device has done much to reduce lost time due to low steam pressure, but a dial pressure gauge is also provided at both effect and pan stages to indicate the boiler pressure. In this way the effect and pan operatives can co-operate with the boiler attendants when steam is low. A signal light is provided at the pan stage and indicates automatically when the steam flow in the factory main exceeds a certain large value. In addition, signal lamps are provided at the boiler station, being manually operated from the pan stage, and indicate when each pan is coming on, running, or coming off.

Except for one or two small engines, the whole boiler steam output is measured by two orifice flow meters, one on the factory main and the other on the mills main. They are mounted on a central panel at the boilers, together with a flow meter measuring the output of the Thompson boiler, two CO_2 recorders, a flue gas pyrometer, the pan signal box, and recorders for feed-water temperature, boiler pressure, and the pressure of factory and mills mains. Each boiler is also provided with a furnace draught gauge of dial pattern.

A flow meter was also provided to measure maceration water, this having the advantage of accuracy and indication of rate of flow. A flow meter was also used to measure in turn: steam to the maceration baths, and condensates from juice heaters, pans and effects. Rotary piston water meters were used to measure water at pan stage and filter, and wetness of steam and vapour was measured by a throttling calorimeter. Effect supply juice was weighed by an automatic juice weigher.

Measurements obtained with the use of the orifice flow meter enabled the author to determine the efficiency at the juice heaters (98·6 per cent.); at the effects (92·1 per cent.); and at the pan stage (89 per cent.). Steam used at the effects and measured as condensate included that required for juice and maceration heating. If one adds the steam condensed at the pan stage, and that used for power production, and subtracts this sum from the total steam output of the boilers as given by the meters on the boiler panel, the closure or difference is obtained.

This closure represents the steam used at the centrifugals and that lost through traps, leaks, gas vents, etc. A set of results is shown below, average figures being used where no meter reading was obtainable. The steam per cent. cane is lbs of actual steam, and not equivalent evaporation from and at 212°F, as used for boiler evaporation calculations. Steam used for power production does not appear in the table, since with actual steam the balance is one of material and not of heat, the steam passing through the engines appearing finally in that used for pans, effects, or lost by leakage. It is thus seen that this total steam balance over the factory reveals a closure of 6·4 per cent. on cane.

Week No.	Used Pans per cent. Cane.	Juice Heaters, Used Effets, etc. per cent. Cane.	Total.	Total by Boiler Meters.	Difference or Closure per cent. Cane.
10	13·3	Average	45·1	52·4	7·3
11	14·0	below	45·8	53·2	7·4
12	13·8	(31·8)	45·6	52·9	7·3
13	—		45·7	52·8	7·1
14	14·5		46·3	52·8	6·5
15			45·7	52·2	6·5
16	Average	31·5	45·4	50·4	5·0
17	above	30·8	44·7	50·3	5·6
18	(13·9)	31·9	45·8	52·1	6·3
19		32·9	46·8	52·2	5·4
			Average		6·4 (±0·3)

Double Liming at Oaklawn Factory, Louisiana. W. D. NELSON. *The Sugar Journal*, 1940, **3**, No. 2, pp. 23-27.

In the double liming process now followed at the Oaklawn factory of the South Coast Corporation, La., the raw juice is limed cold to approximately 6·0 to 6·4 *pH*, heated to 218 to 220°F. (103 to 104°C.), and then limed hot to the optimum *pH* of 6·8 to 7·0, these liming operations being carried out in two special reaction tanks equipped with certain automatic accessories. This method of working gives a very uniform defecation and a very even mud flow; the massecuites boil better in the pans than formerly, and the purging of the low grades has also improved. Some particulars are here given of the equipment used.

In the main juice line connecting the raw juice receiving tank with the mixing tank is a butterfly valve connected to a simple system of levers which actuates a pivoted funnel in a weir box, so that when a tankful of juice is discharged, the funnel is

moved into a constant stream of 5° Bé. lime, thus by-passing a proportionate amount for the tempering of the juice. This stream of lime is made to impinge on a rapidly revolving disc driven by the propellor shaft, by which it is thrown on a film of the juice flowing along the outer rim of the tank down a slightly inclined funnel-shaped surface to the centre of the tank, in this way bringing about a very intimate mixing of the milk-of-lime with the cold juice.

Following this, the limed juice enters the main body of the tank, where by means of a revolving propellor it is circulated downwards through a cone, and then upwards between the cone and the sides of the tank, a continuous circulation of the limed juice being thus brought about. At this stage (as explained above) the reaction is adjusted to 6·0 to 6·4 *pH*, about three-quarters of the total lime entering the juice being then added. The capacity of the mixing tank is such that the juice circulates in it for at least 6 min. before it is pumped into the heaters to be raised to 218 to 220°F., which allows ample time for the action of the lime on the juice.

It then enters the second mixing tank (similar to the first) where the hot juice is circulated by a large 4-bladed propellor revolving at a comparatively slow speed, and forced to pass through an intricate series of baffles. Milk-of-lime is added by causing a stream of it to impinge upon a cone attached to the main shaft, which distributes it evenly against a film of juice flowing down the inside of a conical downtake. The limed juice circulates in this tank for about 6 to 8 min., after which it overflows into a Gilchrist settler. As the juice leaves the tank, a small quantity of it is by-passed to the electrode flow chamber of a *pH* recorder, the rate of flow of the milk-of-lime being adjusted to give the desired final *pH*, generally (as stated) 6·8 to 7·0, though sometimes lower, depending on the results of sedimentation tests which are being made all the time.

At the Terrebonne factory of the South Coast Corporation a similar equipment was used, but for optimum results the *pH* of the clarified juice had to be maintained at 6·4 to 6·5 *pH*. At 6·8 to 7·0 *pH*, although the juice was much clearer, more molasses was produced in the boiling-house, and curing was more difficult. At Terrebonne also the sugars pro-did not work well in the refinery. It was only when this factory had changed over to compound clarification that the refining quality of its sugars was improved. On the other hand, at Oaklawn double liming has proved generally satisfactory, and its use is being continued in the coming season.

Desaccharification of Molasses. W. L. McCleery. *Reports of the Hawaiian Sugar Technologists, 2nd Meeting*, pp. 104-106.

Laboratory investigations have been begun in Hawaii on the problem of the extraction of the sugar remaining in final molasses by the saccharate process. It was quite definitely shown that the glucose must first be removed from the molasses before the sucrose can be recovered as calcium or barium saccharates.

Selective fermentation of the glucose appears to be feasible, and to be capable of being controlled so that there is very little loss of sucrose, if any. Two strains of yeast have been studied, namely the Olivarius yeast and *Cryptococcus glabratus*. Optimum conditions are 44 to 46° Brix at 6·7 to 6·9 *pH* for the first, and 39 to 42° Brix at 6·2 to 6·5 *pH* for the second yeast.

The time required for the complete elimination of the fermentable glucose ranges from 24 to 48 hours when using a 20 per cent. inoculum, and rapid agitation by compressed air speeds up the reaction materially. Pure culture inoculum appears to be required every third or fourth batch. The alcohol content of the fermented molasses ranges from 2·5 to 3·5 per cent. by volume, depending on the amount of glucose originally present in the molasses, and on the yeast used.

Sugar can readily be precipitated from the molasses thus fermented as either calcium or barium saccharate, both of which appear to filter well and wash readily. It is necessary, however, to give the fermented molasses a preliminary clarification before saccharates of satisfactory purity can be formed. This can readily be carried out at a *pH* between 11·0 and 11·6 with lime alone, and without any dilution, the amount of CaO used being 8 to 12 per cent. on the sucrose in the molasses.

This clarified molasses can be filtered without difficulty, and is then ready for the addition of the CaO or BaO. It is found that the purity of the calcium or barium saccharate, and the recovery of the sucrose, depend greatly upon the quantity, quality and the degree of fineness of the quicklime added. About 130 per cent. of CaO, and from 85 to 110 per cent. of BaO, on the sugar in the molasses is indicated for satisfactory working.

Using a fair grade of quicklime, and with efficient cooling and mixing apparatus, it should be possible on the commercial scale to secure saccharate purities averaging 85° true purity. Actually, recoveries up to 94 per cent. of the sucrose in the molasses were obtained using calcium saccharate as the precipitant. Barium saccharate purities were a little lower, but a possibility worth studying is whether the barium saccharate could not be precipitated without the necessity of re-evaporation to about 85° Brix.

The practicability of the desaccharification of waste molasses in such a manner is at present a question of economics, and its possibilities appear to lie not in a straight desaccharification process, but in one combining the recovery also of yeast alcohol, carbon dioxide and potash, the latter from the waste saccharate liquors. It is also believed that the

complex vitamin B_6 might be separated from the waste desaccharification liquor. No attempt has been made at this stage to estimate the possible costs of such a process of extracting sugar from molasses, as it would require more definite data based upon pilot plant operation.

Manufacture of Rich Inverted Molasses with Invertase Yeast. JULIO C. GONZÁLEZ MAIZ. *Proceedings of the 13th Annual Conference of the Association of Sugar Technologists of Cuba*, pp. 181-189.

Some further particulars are now given of the manufacture of inverted molasses with the use of so-called invertase yeast, that is a special type of yeast, possessing a very high hydrolysing power towards sucrose.[1] It is put up in 80 lb. packages, and in appearance does not differ appreciably from ordinary bakers' yeast. It costs 17 cents per lb. delivered, and will retain its activity for a week at a temperature below 10°C.

The cycle of inversion adopted will depend on the capacity of the tanks available for the inversion, but it is advisable to effect the inversion in the shortest time convenient to avoid loss of total sugars at the temperature of reaction. Consideration is given to the prevailing cost of the total sugars; and, based on a price of 60 cents per 100 lbs of molasses, and one of 17 cents per lb for the invertase yeast, the ideal cycle is between 10 and 12 hours, not including an hour and a half allowed for sterilization.

Two syrup tanks working alternately will suffice, both equipped with coils for compressed air and with water hose for cleaning (or a couple of crystallizers may be used). Two 20-litre (4½ gallon) enamelled buckets hold the invertase yeast, and a 12 in. semi-circular strainer is require to separate and disintegrate particles of yeast. After half the addition of yeast has been made, 2 minutes' agitation with air is carried out, and when the addition has been completed, agitation is effected for another 2 minutes.

A temperature of between 55 and 60°C. is maintained in the tanks, and inversion is carried to a polarization of −9°V. Next comes sterilization, which is carried out at a temperature of 80 to 90°C. and is maintained for a period of 1½ to 2 hours, following which the syrup is pumped to the supply tanks of the vacuum pans.

There it is mixed with about 40 per cent. of uninverted syrup, or at least with sufficient to give a blend having a purity of about 20°. Concentration in the vacuum pans should be carried to 85° Brix, after which it is necessary to cool down the syrup in crystallizers.

Invertase produces an inverted molasses lighter in colour than does HCl, H_2SO_4 or other acid. It is noticeable that the yeast treatment actually has a decolorizing effect. During storage, fungoid growth may take place on the surface of the molasses, which is to be avoided by the addition of crude oil to form a protective film, or some bleaching powder may be added.

Lastly some cost figures may be stated. Using a cycle of 10 hours and a *pH* of 6·4, the cost of the invertase yeast per 1000 galls. of inverted molasses was found to be $1·15; or for a cycle of 12 hours $1·10; that is, $50 more per million galls. in the first than in the second case.

A Proposition in Steam Economy. J. V. HAYDEN. *Proc. Queensland Soc. Sugar Cane Tech., 11th Conf.*, 1940, pp. 17-21.—The proposition was submitted by the writer to a Queensland mill when expansion in evaporation was considered essential in order to bring evaporator capacity into line with that of other stations. This particular mill had a quadruple plant of 10,000 sq. ft. heating surface, and there was available at a very small cost a discarded unit of 3,000 sq ft. from another mill. The proposal provides for the installation of the new unit as a pre-evaporator, the vapours to supply the maceration baths, the pans, and the final increment for the heaters. Per 100 tons of cane, expressed in million B.T.U., the proposed change was summarized as follows:—

	Old System.	Proposed System.
"Booster" heater	5·89	Nil
Maceration baths	14·48	Nil
Pans	24·59	Nil
Quadruple Effets	51·85	40·64
Pre-evaporator	Nil	44·96
Totals	96·81	85·60

This represents an overall saving of $11{\cdot}21 \times 10^6$ B.T.U. per 100 tons cane in the steam consumption of the factory. Assuming the heat available from 1 lb. of bagasse with 48 per cent. moisture as 3,700 B.T.U. and the average boiler efficiency as 60 per cent., a saving of 2·27 tons of bagasse per 100 tons cane is possible. With a season's crushing of 80,000 tons of cane, the saving would be 1,800 tons of bagasse, equivalent to 900 tons of wood per season. Even where there is no deficiency the method would be desirable, for the manufacture of building boards from surplus bagasse is now an established industry in Australia.

Denaturants for Ethyl Alcohol. VICTOR L. DE LA TORRE. *Bol. soc. quim. Peru*, **6**, No. 2, pp. 9-15; through *Chem. Abs.*, 1940, **34**, 7525.—Various common denaturants are discussed. A good denaturant for potable alcohol is prepared by passing vapour of kerosene and steam through a tube filled with a catalyst (not named) and heated to 600°. The product is rich in unsaturated hydrocarbons and has good solubility in 78 per cent. alcohol.

[1] See *I.S.J.*, 1940, p. 258.

Review of Recent Patents.

Copies of specifications of patents with their drawings can be obtained on application to the following—*United Kingdom:* Patent Office, Sales Branch, 25, Southampton Buildings, Chancery Lane, London, W.C.2 (price 1s. each). Abstracts of United Kingdom patents marked in our Review with a star (*) are reproduced with the permission of the Controller of H.M. Stationery Office, London, from the Group Abridgements issued by this Department. Sometimes only the drawings are so reproduced. *United States:* Commissioner of Patents, Washington, D.C. (price 10 cents each). *France:* L'Imprimerie Nationale, 87, rue Vieille, du Temple, Paris. *Germany:* Patentamt, Berlin, Germany.

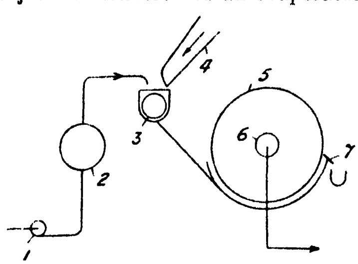
UNITED KINGDOM.

Clarifying Sugar Juices. THE MIRRLEES WATSON CO. LTD. and THOS. STORRAR, both of 45, Scotland Street, Glasgow, C.5. 527,747. April 20th, 1939.

This invention relates to the art of clarifying limed sugar juices and may be regarded as a development of the process described in patent specification 22,387 of 1906.

In that specification there is described a process of clarifying sugar juices consisting in liming, heating and filtering the juices, the separation of impurities or flocculent matter from the solution being effected by forcing the solution through filter-presses.

The present invention consists in a continuous process of clarifying sugar juices comprising the steps of heating juice that has been limed without previous sulphitation, mixing the heated juice with filter-aid, such as finely divided bagasse, and then filtering the juice in a series of continuously-operable vacuum filters of the rotary drum type from which the clear juice is delivered to an evaporator.



In practice, the limed cane juice is pumped through heaters in which it is heated to 200 to 260°F., and thence sent to a mixer where it is mixed with filter-aid, such as finely divided bagasse, and from which it passes to a continuously-operable vacuum filter of the rotary drum type. There the clear juice is separated from the impurities and delivered to an evaporator for concentration.

Referring to the drawing, the limed sugar juice to be clarified is sent by means of a pump 1 to a heater 2 whence it passes to a vessel 3 where it is mixed with a filter-aid delivered by means of a chute 4. From vessel 3 the juice passes to a rotary vacuum filter 5 from which it is delivered in clear condition at 6 to pass to an evaporator. Cake with impurities is removed at 7.

Claim is made for : A continuous process of clarifying sugar juices comprising the steps of heating juice that has been limed without previous sulphitation, mixing the heated juice with filter-aid, such as finely divided bagasse, and then filtering the juice in a series of continuously-operable vacuum filters of the rotary drum type from which the clear juice is delivered to an evaporator.

Defecating Sugar Solutions (using Bentonite). L. N. REDDIE (communicated by the GIRDLER CORPORATION of Louisville, Kentucky, U.S.A.). 523,859. January 16th, 1939.—Cane juice is mixed with about 0·1 per cent. of Bentonite (on the Brix) preferably in the form of a slurry, which mixture may be heated to about 88°C., whereupon an agglomerate forms. This is separated by suitable means, as a subsiding tank, a continuous clarifier, or a centrifugal machine. The clarified liquid obtained may be subjected to any suitable additional treatment, such as with activated carbon, animal charcoal, or chemical decolorizing agents, or it may be directly passed to the evaporator for concentration to the state of syrup. If desired, the syrup may be subjected to any suitable additional decolorizing process, e.g., with bonechar. By Bentonite is understood the mineral either in a natural or treated condition as listed in Technical Paper 438, Bureau of Mines, Department of Commerce, U.S.A., by DAVIS and VACHER. It is stated to have an affinity for the soluble and colloidal nitrogenous matter in juice, and for colouring matters as chlorophyll, anthocyan, saccharetin, water-soluble polyphenols and tannin-like substances; it is also said to react with certain inorganic constituents of the cane juice.

Producing a Refined Syrup (using Phosphoric Acid, Chlorine, Carbon, etc.). APPLIED SUGAR LABORATORIES, INC., of 120 Wall Street, New York, U.S.A. 525,014. February 11th, 1939; convention date, April 5th, 1939.—In accordance with this invention a process is provided of producing a refined syrup directly from un-affined raw sugar liquor by chemically bleaching it. In an example, after being brought to a pH of 7·2 to 8·0 with lime, the syrup is treated with phosphoric acid to bring the pH to 6·0 to 6·8. This addition is carried out with vigorous agitation and with the addition of diatomaceous earth, after which it may be passed through a "super-centrifuge." Next the filtrate is mixed with about 1 per cent. of finely divided activated carbon at a temperature of from 82 to 93°C. for 20 to 30 min., following which it is treated with about 0·3 per cent. of calcium hypochlorite, and after that with phosphoric acid or monocalcium phosphate. As a final step, traces of free chlorine are removed by percolation through granular carbon, or other dehalogenating agent.

Continuously Purifying Molasses. AKTIEBOLAGET SEPARATOR, of Stockholm, Sweden. 509,347. Feb. 25th, 1938.—Claim is made for a continuous process of purifying molasses (for use for the manufacture of yeast, etc.), which consists in washing and diluting it, and subjecting the solution to centrifugal treatment in two or more stages in a series of centrifugals having means for intermittently or continuously discharging solid matters with a certain amount of the molasses.

Steam Condensers and Tubular Heat Exchangers. WORTHINGTON-SIMPSON, LTD., of Newark-on-Trent and MARK JENNINGS. 511,712. March 16th, 1938. - Claim is made for: "A steam condenser or like tubular heat exchanger (for use in sugar factories, breweries, etc.) comprising a casing having a door or removable closure and means for admitting steam or vapours thereto, and adapted to house a water or other cooling liquid circulation unit comprising a series of sections (detachable) secured together side by side in liquid communication and removable as a unit from its casing, each section comprising a bank of tubes extending between headers provided with covers or doors."

Base-exchanging Absorbents (Active Carbon). CARBO-NORIT-UNION VERWALTUNGS GES m-b-H., of Frankfurt-on-Main, Germany. 509,859. March 17th, 1938; convention date, March 17th, 1937 (Germany).—Claim is made for a base-exchanging adsorption medium capable of withstanding changes of temperature which comprises subjecting uncharged active carbon in a dry state to the action of sulphuric acid, sulphuric anhydride or oleum at a temperature below 250°C. for a period of at least one hour, and thereupon washing the acid out of the reaction product. Claim is also made for the application of the product claimed above to the elimination from liquids of metallic ions as well as any colouring, flavouring or odorous constituents that may be present in it.

Dry Reagents for Sugar Testing. DENVER CHEMICAL MFG. CO. LTD., of New York, U.S.A. 524,426. January 31st, 1939.—Claim is made for "a dry reagent for direct testing without external heating for the presence of sugar in solutions comprising a mixture of a bismuth compound and a caustic alkali, which react to produce a black colour in the presence of sugar, and including a water-free silicate having a capillary structure." A lead and/or magnesium compound may also be present. Proportions found to be effective are: bismuth oxychloride, 12·5; sodium hydroxide, 56·5; magnesium oxide or carbonate, 0·05; lead nitrate, 0·05; balance, sodium silicate. In making the test, about 0·2 grm. of the reagent is moistened with the liquid under examination, when in the presence of 0·1 per cent. of sugar, a grey colour appears, and with larger amounts a distinct black one.

UNITED STATES.

Sugar Granule Manufacture.[1] JOHN W. SCHLEGEL and LOUIS LANG (assignors to the NATIONAL SUGAR REFINING CO., of New Jersey, U.S.A.). 2,205,177. June 18th, 1940.—Claim 1: The process of manufacturing a sugar product in granule form, which comprises cooking a sugar liquor containing crystallizable and non-crystallizable and flavouring components of the raw sugar liquor to a condition of thick syrup, subjecting the hot syrup while in process of cooling to a rubbing and rolling treatment between relatively moving surfaces spaced apart not substantially greater than the desired maximum granule size and until the hot paste becomes mainly constituted of crystal agglomerates of pill-like form constituting the granules, and ceasing such treatment when such condition has been reached and then cooling and drying the granules to form a free-flowing product. Claim 6: The process of reducing the size of crystal-agglomerates which comprises exerting pressure on them between resilient-surfaced rolls sufficient to overcome their cohesive strength, the roll surfaces being soft enough not to crush the surface crystals.

Application of Reagents in Counter-Current Extraction. MAX J. PROFFITT, of Washington, D.C. (assignor to THE GOVERNMENT OF THE U.S.A.). 2,188,919. Feb. 6th, 1940.—Claim 2 reads: In a counter-current extraction process (e.g., as applied to the extraction of levulose from vegetable tissues containing it) in which cells of material to be extracted are introduced at the foot of an extraction column and progressively advanced toward its head; while solvent is introduced at the head of the column and progressively flows as flood liquid toward the foot of the column, the method which consists in selecting a cell position at an intermediate point in the column for a reagent treating zone, introducing into the cell occupying the selected position a reagent substantially non-miscible with the flood liquid thus displacing the flood liquid therefrom to the cell next in order, treating the reagent-containing cell with reagent while by-passing it with flood liquid, re-directing flow of flood liquid into said cell to displace the reagent to the next cell to be reagent-treated, and continuing extraction of the treated material in the remaining cells of the column from the intermediate position to the head of the column

Decolorizing Liquids. EDWIN G. STEELE, of Dallas, Tex., U.S.A. 2,206,337. July 2nd, 1940.—Claim is made for: The method of decolorizing liquids, which comprises contacting a liquid containing colouring matter with a mass of granular adsorbent decolorizing material which removes colouring matter from the liquid, revivifying the used decolorizing material by a treatment which includes heating it

[1] See also U.K. Patent 455,062; *I.S.J.*, 1937, p. 160.

to a temperature sufficiently high to burn out adsorbed organic matter, whereby the decolorizing power or some granules of said decolorizing material is decreased, classifying the revivified granular decolorizing material into at least two portions including a portion characterized by higher decolorizing power than the unseparated material, and a second portion characterized by lower decolorizing power than the unseparated material, withdrawing said portion of lower decolorizing power a sufficient further quantity of granular decolorizing material having at least equally high decolorizing power to make up the desired total mass of decolorizing material, and contacting the resulting mass of decolorizing material with a further quantity of said liquid to remove colouring matter therefrom.

Adsorbent Material (Decarbonized Bonechar and Activated Charcoal). F. A. BODENHEIM and C. E. HEATH (assignors to APPLIED SUGAR LABORATORIES INC., of New York. 2,209,069. July 23rd, 1940.—Spent bonechar is denuded of carbon by combustion, leaving what may be referred to as bonechar "skeleton" which is mechanically mixed with a small proportion of an activated carbon, about 2 per cent. It is found that this mixture possesses certain remarkable properties: (1) it has a very high decolorizing capacity; (2) when sugar syrup is percolated through it the carbon remains in union with the skeleton to such an extent that the filtrate is clear; and (3) when the spent mixture is agitated with water the carbon with its adsorbed impurities readily separates. Then the residual skeleton from which the carbon has separated can again be mixed with a fresh charge of carbon. Thus the process of regeneration comprises a "washing out" of the spent carbon and replacement thereof by fresh carbon. Thus the carbon need not be itself revivified at all. Rather it is separated when its decolorizing power is exhausted, and this separation may be accomplished by merely agitating with water. Advantages claimed for this method of using carbon are that substantially less (in a typical case 80 per cent. less) is required to be used in the combination described to accomplish a given degree of decolorization than when applied in the conventional way; and that it possesses a marked capacity for removing non-sugars, 200 per cent. more being removed by it than by carbon as ordinarily applied.

Stock Food containing Carbonatation Scums. HANS FATTINGER, of Stadl, Raab, Styria, Austria. 2,170,713. August 22nd, 1939.—Claim 1: The method for the production of stock feed comprising acting upon a base feeding material with an emulsion that is formed by the admixture of the carbonatation sediment from sugar manufacture and one of the group consisting of molasses and syrup from beet and cane sugar manufacture and wood sugar.

Beet Harvester. JOHN ZUCKERMAN, of Stockton, Cal. 2,214,949. September 17th, 1940.—Claim 5: A beet harvester comprising a rotatable drum, a band within said drum, a transverse series of spikes projecting from within said drum, means joining all of the spikes of said series, a guide engaging said bar and said band, and a spring interposed between said bar and said band and encompassing said guide. Claim 6: A beet harvester comprising a frame extending in the direction of a row of beets, a drum rotatably mounted on said frame to roll upon said row of beets, spikes projecting from said drum to impale beets in said row and to engage clods, a screen upon said frame, means for depositing said beets and said clods upon said screen, means for conveying beets away from said screen, and means for deflecting laterally of said frame clods passing through said screen.

Diffusion Apparatus. DARIO TEATINI, of Hougaerde, Belgium. 2,214,978. September 17th, 1940.—Claim 1: Apparatus for the batch extraction of soluble substances from a comminuted mass of solid organic material by horizontal radial flow of aqueous extracting liquid through the mass, which apparatus comprises a pair of substantially vertical perforated walls arranged to constitute a central duct for the admission of extracting liquid and an annular container adapted to be filled with the material to be extracted, a casing surrounding the outer perforated wall and spaced therefrom to form a collecting space for the extracting liquid after passing through the material to be extracted, doors for hermetically closing the top and bottom of the said annular container, a pipe for the admission of aqueous extracting liquid mounted on the bottom door of the container in register with the central duct and means adapted for filling the annular container with the extracting liquid and for passing a continuous current of the said extracting liquid radially through the material to be extracted.

Recovery of Sugar. ALFRED M. THOMSEN, of San Francisco, Cal., U.S.A 2,210,514. August 6th, 1940.—Claim 3: The method of recovering sugar from plant juices which comprises: Passing the suitably purified juice through a multiple effect evaporator in a direction counter-current to the passage of the heating steam at such a rate that a supersaturated syrup issues from the high temperature effect; next passing said supersaturated syrup, in the direction of the increasing vacuum, through a series of heat insulated crystallizers each one of which is maintained at a progressively higher vacuum than the preceding crystallizer by connecting it with the appropriate vacuum phase of the evaporator, thus obtaining a mobile massecuite from the last crystallizer in the series while the vapour evolved during the cooling process is employed in performing useful evaporation in the evaporator.

Stock Exchange Quotations of Sugar Company Shares.

LONDON.

COMPANY.	Quotation January 21st 1941	Quotation December 20th 1940	1940 Prices Highest.	1940 Prices Lowest.
Anglo-Ceylon & General Estates Co. (Ord. Stock)	$1\frac{3}{16}$ — $1\frac{5}{16}$ per £1 unit of Stock	$1\frac{3}{16}$ — $1\frac{5}{16}$ per £1 unit of Stock	30/3	17/7
Antigua Sugar Factory Ltd. (£1 Shares)	$\frac{3}{8}$ — $\frac{5}{8}$	$\frac{1}{2}$ — $\frac{3}{4}$	14/1½	11/3
Booker Bros., McConnell & Co. Ltd. (£1 Shares)	$2\frac{3}{8}$ — $2\frac{5}{8}$	$2\frac{3}{8}$ — $2\frac{5}{8}$	56/6	45/6
Caroni Ltd. (2/0 Ord. Shares)	1/0— 1/6	1/0 — 1/6	1/10½	9½d.
(6% Cum. Pref. £1 Shares)	$\frac{15}{16}$ — $1\frac{1}{16}$	$\frac{15}{16}$ — $1\frac{1}{16}$	22/6	18/6
Gledhow-Chaka's Kraal Sugar Co. Ltd. (£1 Shares)	$1\frac{3}{16}$ — $1\frac{5}{16}$	$1\frac{3}{16}$ — $1\frac{5}{16}$	26/10½	22/0
Hulett, Sir J. L. & Sons Ltd. (£1 Shares)	24/0 — 25/0	22/0 — 23/0	27/9	18/6
Incomati Estates Ltd. (£1 Shares)	$\frac{3}{16}$ — $\frac{5}{16}$	$\frac{3}{16}$ — $\frac{5}{16}$	5/3	3/6
Leach's Argentine Estates Ltd. (10/0 units of Stock)	6/0 x.d. 6/6	6/0 — 6/6	8/9	4/6
Reynolds Bros. Ltd. (£1 Shares)	$1\frac{13}{16}$ — $1\frac{15}{16}$	$1\frac{11}{16}$ — $1\frac{13}{16}$	38/7½	29/6
St. Kitts (London) Sugar Factory Ltd. (£1 Shares)	$1\frac{5}{8}$ — $1\frac{7}{8}$	$1\frac{5}{8}$ — $1\frac{7}{8}$	36/3	36/3
Ste. Madeleine Sugar Co. Ltd. (Ordinary Stock)	$\frac{5}{8}$ — $\frac{11}{16}$ per £1 unit of stock	11/6 — 13/0 per £1 unit of stock	16/4½	10/0
Sena Sugar Estates Ltd. (10/0 Shares)	$\frac{1}{4}$ — $\frac{5}{16}$	$\frac{3}{16}$ — $\frac{1}{4}$	7/10	3/10
Tate & Lyle Ltd. (£1 Shares)	47/3 — 48/3	46/6 — 47/6	57/9	35/0
Trinidad Sugar Estates Ltd. (Ord 5/0 units of Stock)	5/0 — 6/0	4/6 — 5/6	6/3	3/0
United Molasses Co. Ltd. (6/8d. units of Stock)	24/3 — 24/9	22/9 — 23/3	28/3	15/0

NEW YORK (Common Shares).†

Name of Stock	Par Value.	Closing Price Dec 10th 1940	1940 Highest for the Year	1940 Lowest for the Year
American Crystal Sugar Co.	No par	10	15¼	8
American Sugar Refining Co.	\$100	13½	23⅜	12¾
Central Aguirre Associates	No par	18	26¼	17
Cuban American Sugar Co.	\$10	4⅜	8⅞	3½
Great Western Sugar Co.	No par	21¼	29⅛	18⅜
South Puerto Rico Sugar Co.	No par	18¼	30¾	16

† Quotations are in American dollars and fractions thereof

United States, All Ports.

(Willett & Gray)

	1940 Long Tons	1939 Long Tons.	1938 Long Tons
Total Receipts, January 1st to December 21st	3,728,197	3,981,756	3,961,279
Meltings by Refiners ,, ,, ,,	3,885,847	3,803,649	3,957,147
Importers' Stock, December 21st	49,029	82,929	15,477
Refiners' Stock ,, ,,	229,890	295,160	179,255
Total Stock ,, ,,	278,919	378,089	194,732
	1939	1938	1937
Total Consumption for twelve months	5,648,513	5,604,051	5,690,583

Cuba.

(Willett & Gray)

	1940 Spanish Tons.	1939 Spanish Tons.	1938 Spanish Tons
Carry-over from previous crops	588,293	729,172	456,072
Authorized Production	2,753,903	2,696,517	2,950,000
	3,342,196	3,425,689	3,406,072
Exports since January 1st	2,003,461	2,598,567	2,506,006
	1,338,735	827,122	900,066
Less estimated consumption	150,000	150,000	150,000
Stock (entire Island) December 21st	1,188,735	677,122	750,066

The Market in New York.

Whilst prices in the domestic market show a slight improvement compared with a month ago, the tendency has been barely steady inasmuch as slightly higher freight rates announced on the 9th January resulted in an advance of about three points in the c.i.f. and c. & f. prices with the parity of 2·05 c. c. & f. New York being paid for afloat sugars and 2·08c. for February/March shipment Philippines. These levels were not maintained for long, however, as, with refiners still showing little or no interest, prices dropped back to the parity of 2·02 c. for afloat sugars with more distant positions approximately three points higher. A small recovery was witnessed on the 23rd when 10,000 tons nearby realised the basis of 2·03 c. with 2·05 c. paid for a March cargo. The total volume of business reported is about 105,000 tons including seven or eight cargoes of Cubans of which about four were sold to Gulf refiners on the 17th at 2·00 c. c. & f.

Following the better market on the 9th, a good demand for Refined was experienced on the 10th whilst five days later the general basic price was increased to 4·45 c. effective after the end of January.

Apart from firmer periods due largely to technical operations, the domestic Futures Contract was very quiet with prices inclined to drift towards lower levels but this downward trend was not sufficient to fully offset the occasional advances and on balance, March is one point and May two points higher than a month ago. January delivery has almost reached its expiry date and the liquidation of that position has resulted in rather wider fluctuations with the close last night five points higher than at this time last month.

In the continued absence of any outside demand for Cuban sugars, the world Futures Contract has been almost entirely influenced by the possibilities of an American loan to Cuba in connexion with the suggested proposal for storing Cuban sugar which we commented upon in our last issue. The l test news we have regarding this was received on the 21st January when there were indications that the United States might advance four dollars per bag of 325 lbs. at 3 per cent. per annum on 400,000 tons. This is equal to about 1·23 c. per lb. which, in view of March delivery in the No. 4 Contract quoting at 0·75½ c., would appear to be very high. Whilst our news on this matter is very sketchy so far and our following remark is purely conjecture. it does not seem unreasonable to assume that the above price may be based on the refined product in store in the United States and not on raws f.o.b. Cuba.

During the first half of the period under review the market had a slightly easier tendency but with the loan prospects looking more promising, a moderate recovery has been witnessed recently and quotations are three points to a half point higher on balance.

C. Czarnikow, Ltd.

21, Mincing Lane,
London, E.C.3.
January 24th, 1941.

Eire's Sugar Supplies.—This year the Irish Sugar Company hope to have enough sugar beet under cultivation to supply the total requirements of the country, that is some 100,000 tons of sugar. For the 1940-41 season 70,000 tons of sugar has been produced from an acreage of some 60,000, which was an increase of some 33 per cent. over the figure of the previous season. At present some 35,000 farmers include beet in their crops. The problem of securing sufficient seed has been successfully met by the Irish Sugar Company, who hold plentiful stocks.

Booker Bros., McConnell & Co.—This firm of British Guiana merchants and estate owners made a net profit for the year ended June, 1940, of £138,837, as against £106,688 in 1938-39. This profit included a dividend of £20,585 from the Corentyne Sugar Co. The dividend for the year was maintained at 15 per cent. The sugar crop in 1939 was good, but the 1940 one has been affected by serious drought and will be very short, according to the Chairman of the Company. In the 1940-41 season they will have to contend with increased wages, which, however, may be compensated for to some extent by higher prices for sugar. The Company has recently been having considerable trouble with estates labour, irresponsible strikes and consequent disorder being prevalent, due in the main to malicious agitation.

Medical Value of Sugar.—A "Research Chemist" recently contributed the following remarks to a London newspaper: "As a medical agent, as a strengthener of muscle during intense fatigue, and as an aid to longevity and fitness, sugar is without a rival." He stated that experiments carried out with the aid of the Ergograph (an instrument for accurately registering variations of muscular power) show sugar to give an increase of physical energy ranging from 60 to 75 per cent. Sugar is said also to be serviceable as a surgical antiseptic, which has led to its use on the Continent as a field dressing in war-time.

U.K. Sugar Prices reduced.—From December 16th the retail price of the various assortments of sugar on sale in the United Kingdom was reduced by the Ministry of Food by 1d. per lb. At the end of August it had been found necessary to advance prices by ½d. per lb. to balance increases in cost of freight and raw material during the previous 10 months. Now it has been found possible to lower the price to ½d. below the pre-August prices. The new retail prices per lb. are: Granulated, 4d.; Cubes, 4½d.; Castor, 4½d.; Grocery West Indian, 4½d. Wholesale prices have been lowered as follows, per cwt.: Granulated, 40s. 6d. to 31s. 2d.; Cubes, 45s. 2d. to 35s. 10d.; Castor, 44s. 10d. to 35s. 6d.; and Grocery West Indian, 42s. 6d. to 33s. 2d.

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Notes and Comments.

The War.

The winter months now approaching their end have placed the usual restrictions on active warfare in Europe. Only in North Africa, where it was the right season of the year for a white man's offensive, has progress been achieved—and that to an unexpectedly successful extent. Since the end of December, when the Luftwaffe tried to set the City of London on fire from end to end and succeeded in bombing or burning out extensive blocks of buildings here and there, there has been a comparative lull in the attacks aimed on Britain by the German air power; desultory night attacks on various towns have alternated with spells of inactivity supposedly due to bad weather on the Continent. But the German Luftwaffe have more recently had other fronts to consider; they have had to dispatch a considerable number of bombers to assist MUSSOLINI in the Mediterranean, and they are massing in the Balkans an air force the extent of which can only be guessed. So, for the time being, it looks as though they prefer to reserve their air personnel and material for the inevitable Spring offensive on this country rather than deplete their forces in less favourable conditions of attack.

For the destruction of the offensive power inherent in Great Britain, the hub of the British Empire, remains HITLER'S primary object, and till this country is subjugated all other offensives by the German military arm on the rest of the Nazi periphery must remain comparative sideshows which may serve useful means to the end but cannot in themselves be decisive. So the main attack in 1941, above, below and on the surface, must be directed against Britain. The winter lull can have been employed by Germany only to build up vast material and armaments for such an attack. If has, of course, also given this country useful time to strengthen the defences and to construct the means for a counter-offensive when the opportunity comes. But the workshops of this country *plus* those of the Empire cannot very well equal in output the vast manufacturing resources which Germany now possesses, both within her own borders and in the countries which she has seized since the Spring of 1940. To overcome this inequality we need the material help of the United States, and this is being readily given on an ascending scale which augurs well for our ability to carry out our plans of defence and should ultimately play a large part in furthering the eventual task of carrying the war into the enemy's country. The political attitude of the United States towards this war has undoubtedly, during the last few months, developed a remarkable swing-over in favour of this country and its allies. Once the Americans realized, as they did last Spring, the nature of HITLER'S depredatory ideas, there was a growing demand in the States for assistance to be given to the victims of attack; but with their biggest political event—the Presidential election—due to run its several months' course, parties were unwilling to combine in a common cause, and the isolationists had a longer run of success in urging non-compliance with the prevailing feeling than would probably have been the case in a less politically contentious year. But with Mr. ROOSEVELT'S return to power in November, the political aspect of the matter took a back seat and unity towards a very necessary task was quickly developed. This unity has been very much enhanced by the unselfish and statesmanlike attitude of the defeated Presidential candidate, Mr. WENDELL WILLKIE—a man himself of German origin—who paid a lightning visit to England to see for himself the real position and was given a welcome commensurate with his good intentions. On his return to the States, there is no doubt which way he will influence his party towards assisting the Government in office, who realize far better than the few eminent die-hard isolationists that if Britain falls in the struggle the United States on her part will be isolated in a world of Dictators eager to subjugate in its turn the remaining big stronghold of Democracy. For the other countries of the New World, unless they would agree to stand together, would easily fall victims, one by one, to the insidious leaven of totalitarianism.

The Spring Offensive.

The German attitude, at the outset of American moral and material assistance to the Empire, was one of comparative certainty that it would come too late to be of use. This view has since been abandoned in the light of positive accomplishment, and it is now realized in Berlin that the longer the German Command delay operations, the greater the material forces from overseas they will have to contend with. From all accounts American assistance may take the best part of a year to reach its zenith, so German policy is necessarily forced to act with the minimum loss of time, if the dice are not to be hopelessly loaded against it

For this reason, if for no other, expert opinion seems disposed to agree that the coming weeks will produce a major attack on this country by all the forces that Germany can place in action. An attempt at invasion, both by air and across the water, seems a likely eventuality unless indeed the German Command deem that it would prove too desperate a venture against such a fortress as this country undoubtedly now is. Not that the Nazi leaders would hesitate over the inevitable vast loss of lives that would result, providing they succeeded. But failure would prove such a setback to German prestige that there are some who think it may not be attempted at the present stage, save in the disguised form of heavy air attacks. HITLER has another weapon in his armoury on which he is supposed to set great store: a greatly enhanced U-boat attack on our shipping in the Spring, which, if not effectively countered, would be bound to affect our vital imports of food and war material. Success in this direction might, in his view, set the stage better for a subsequent attempt at invasion So the world is left guessing the precise order of the German programme of attack, and we in this country can only keep prepared for any eventualities

The Mediterranean.

Meanwhile, Italian Africa and the Balkans remain the hot spot of the news. The unexpectedly quick conquest of Cyrenaica by comparatively small but well trained and skilfully commanded British forces has undoubtedly upset the plans of the Axis and orced HITLER to come to the aid of his partner. The campaign against the Italians in Eritrea and Abyssinia makes as good headway as the vast extent and wild nature of the country can be expected to allow. But the danger spot, as we write these lines, is the Balkans,[1] where the Germans have "peacefully penetrated" Rumania and Bulgaria, one after the other, with German troops and armaments, and it seems but a matter of a few weeks ere they challenge Greece on behalf of Italy, if they do not also threaten Turkey. The weather in the Balkans is still unfavourable for ground offensives, but that drawback will soon cease, and the German army, which since it overran France last June has played a waiting game, may resume its task of trying to conquer the few remaining spots of Europe not yet in its occupation. Meanwhile, Russia remains her usual enigma, and the world gets the impression that, much as she would like to put a spoke in the wheel of HITLER's *Drang nach Osten*, she dare not challenge the German might at this stage of Russian military equipment. But if no one else does in the meantime, her chances of doing so subsequently must be very small.

U.S.A. Sugar Consumption during 1940.

According to Willett & Gray, the consumption of sugar in the United States during the calendar year 1940 amounted to 5,712,587 long tons refined value, as against 5,648,513 tons in 1939, an increase of 64,074 tons or 1·13 per cent., and represents a *per capita* figure of 96·62 lbs. This is the largest total of sugar consumed since 1929 when 5,810,980 tons (108·13 lbs. *per capita*) was consumed. The poorest year since 1929 has been 1934, when only 5,134,746 tons was absorbed. The highest *per capita* consumption of recent years was in 1937 with 98·30. Since the 1929 consumption figure was the largest on record, that of 1940 shows the second largest.

Of the 1940 total of 5,712,587 tons, 3,537,536 tons consisted of sugar processed by cane sugar refiners (as against 3,485,852 tons in 1939), 1,428,065 tons was manufactured by the beet sugar factories (against 1,391,972 tons), and 746,986 tons comprised direct consumption white and raw sugars (both insular and foreign). Expressed otherwise, the sugars (cane and beet) from domestic (home and overseas) sources amounted to 4,115,828 tons, the cane sugar from Cuba to 1,593,547 tons, and the foreign full duty sugars to 3,212 tons These last, foreign sugars, have dwindled from 40,287 tons in 1937 and 17,105 tons in 1938. The consumption of direct consumption sugar shows a decline as compared with 1939, when the total was 770,689 tons.[2] Of domestic sugars, as compared with 1939, Louisiana and Florida supplied 168,631 tons less, Hawaii 63,967 tons more, Puerto Rico 65,498 tons less, and the Philippines 14,785 tons more, while U.S. Beet supplied 36,093 tons more.

The price of raw sugar for the year 1940, according to Willett & Gray's records, averaged 2·79 cents per lb. and that of refined sugar at New York with taxes and discounts deducted 3·809 cents per lb. These prices compare with 2·99 cents and 4·03 cents respectively in 1939.

World Sugar Production in 1940-41.

On another page of this issue we reproduce Willett & Gray's first estimates of World Sugar Production in 1940-41, compared with the actual figures of the

[1] Not to mention the Far East, where Japan is at least working up a war of nerves.
[2] This is Willett & Gray's revised figure; the original computation a year ago was 952,116 tons.

four previous years. In these abnormal days of war-disturbed economics and statistical information, it is only to be expected that these New York sugar statisticians should wish to emphasize strongly the fact that some of these estimates are only tentative; nevertheless they look for a considerable decrease in consumption this season.

The principal factor governing production this year, according to Willett & Gray, is the ability of producers for the world market to find a market at all under present international conditions. They have no means of knowing whether they can market a crop after making it. Writing in mid-January, it could only be said with certainty that Cuba would make her U.S. quota and her usual requirement for local consumption; any additional production for the world market apparently then hinged on securing a loan from the U.S. Export-Import Bank to finance such production. Later news to hand from New York suggests that an agreement has virtually been reached between Cuba and the U.S.A. for a loan of $4 per bag, equivalent to about 1·23 cent per lb. f.o.b. Cuba, on 400,000 tons of world quota sugars; this arrangement, if confirmed, would allow Cuba to produce with safety a crop of 2,300,000 tons.

Producers in both Dominican Republic and Haiti who export chiefly to Europe may have to produce larger quantities of molasses this season—for which there is fortunately a demand—and less sugar. The U.S. domestic beet crop now ending will prove a record one, but the next crop is to be materially reduced. The Louisiana crop has turned out very poorly owing to unfavourable weather. In the case of Puerto Rico this island is restricted to a manufacturing quota of 810,325 long tons, in spite of the fact that there is enough cane in the fields to make nearly 1,100,000 tons of sugar.

The veil of censorship, remark Willett & Gray, hides a clear view of the picture in Europe, and accurate estimates in a number of instances are impossible. Efforts have been made to increase production in some of the countries, war usage rather than domestic consumption being the aim. Apparently this has been successful to some extent if the acreages on which these production estimates are based were fully harvested and can be believed. France, of course, is the principal exception.

Sugar Freights in 1940.

It is practically certain that there will never be another year to equal 1940, the succession of bewildering and staggering events in merchant shipping circles being unparalleled in history. It was not until late autumn that any degree of stability was achieved and owners were able to take stock of the very changed situation. Neutral owners disappeared from the scene with amazing rapidity, whilst trading became confined to very narrow limits.

The beginning of the year found Britain with a very inadequate fleet and British owners protesting against the totally unremunerative freights offered them by the Ministry of Shipping, whilst neutral owners enforced successive advances in freights as chartering was very active in all sections. Early in March the M.O.S. decided to replace the various Government chartering committees then operating on the Baltic Exchange by a Central Chartering Office at the Ministry and to set up a small committee on the "Baltic" to fix neutral tonnage on Government account. This caused widespread resentment and alarm amongst all branches of the industry, a repetition of the mistakes of the last war being foreshadowed, whilst discussions still continued regarding the payment to be made to British owners.

In the meantime, neutral owners became very reserved and took full advantage of the situation to push up freights. Shippers were inclined to hold back, hoping that the requisitioning scheme would soon result in a better supply of tonnage; but, as this took longer than originally anticipated to materialize, shippers were forced to cover their urgent requirements at substantial advances in freights, these then being in many cases well above the best of 1915. The shipbuilding industry was taken over by the Government and all possible yards put into commission.

The invasions of the second quarter and the consequently unexpected and fortuitous additions made thereby to the mercantile fleet under British control, completely upset everybody's calculations, and the tide of freight rates turned in shippers' favour, an unheard-of procedure in war-time. This addition of over 8 million gross tons of ex-neutral vessels caused the M.O.S. to become virtually independent of the few remaining neutrals for the time being, with the result that there was an all-round sharp decline in freights. In view of this, and also in face of the increased seriousness of the general situation, British owners finally reluctantly agreed to compromise with the M.O.S. and accept 6s. per ton d.w. on time charter for the hire of their ships.

The third quarter found world trading sadly crippled, the U.S.A. having become by that time the hub of commerce. Ever-expanding chartering was in evidence for loading various cargoes, especially ores, to the U.S.A., whilst a steady stream of grain, armaments, etc., flowed from America to the U.K.

With practically all Europe and Scandinavia, as well as the countries formerly reached by the Mediterranean route, cut off from trading, the few remaining neutral owners found it far from easy to secure business at anything like the rates they had been anticipating.

The end of the year saw a steady, but very gradual and moderate, rise take place in neutrals' freights on account of the ever-increasing flow of business to and from the U.S.A. Another contributing factor to the rise was the heavier losses suffered by tonnage under British control from U-boat action in November, when the question of a sufficiency of merchant tonnage again loomed on the horizon.

In the national interest, only very little of the chartering arranged by the M.O.S. was made public, whilst the fixtures effected with neutral owners were also not always disclosed, so that information was scanty throughout the year. In May the British Government bought the entire exportable surplus of the coming season's sugar crops of Mauritius, Australia, South Africa, Fiji, and the British West Indian colonies, the total quantity involved being about 1½ million tons. The shipment of most of this was taken care of by requisitioned tonnage.

Sugar chartering from Cuba was active during the first half of the year, several British steamers being fixed early in January at the Government's rate of 41s. a ton although at the same time neutral owners secured 80s. and also $17 to Eire By February the rate to the latter destination had risen to 100s. for neutral tonnage. March saw a very strong demand for tonnage in all sections, and up to $26 was paid to Antwerp, whilst neutral vessels secured 120s. to the U.K. Early April saw $21 to $24 paid to Bordeaux and Dunkirk respectively, and in May $24 was secured for April, during which month neutral owners were asking 115s. to the U.K., but this was not forthcoming as the M.O.S. was not inclined at that time to pay more than 95s. By June, however, tonnage was obtained for W.C.U.K, Cork or Dublin at 102s. 6d., whilst in July the Government quoted 95s. to Eire, and $12 was offered for Lisbon or Bilbao. Business, however, failed to mature, and by the end of the month 100s. was offered for Eire, but owners were reserved and were also not anxious to consider offers for loading to Spain. Eventually neutral tonnage secured 112s. 6d. to the U.K. in August, after which actual chartering in the open market fell off as owners' indications were on the up-grade, 115s. being repeatedly mentioned for Eire. Freights from Cuba to the U.K. during 1939 ranged from 15s. to 65s.

During the spring and early summer a few cargoes of refined sugar were shipped from the U.S. Northern Range or the Gulf to the French Atlantic at $17 to $17·50, and to Marseilles at $18.

Sugar chartering from the Philippines to the U.S.A. was more in evidence than usual, freights rising from $10 in January to $16 by May, but there was a decline to $14 in June when actual chartering fell off somewhat, owners not being attracted by shippers' offers of $13 to $14 during August and $15 in October. Other chartering from the Philippines included 100s. paid in January for neutral tonnage to Marseilles.

Quite remarkable activity was seen in Peruvian sugar chartering, a good demand for tonnage being maintained throughout the year. In January $19 was paid to Casablanca, and in February $24, and also 105s., to Marseilles. March saw the payment of $26 to Antwerp, 100s. and also $20 to Marseilles, and 120s. to the U.K., whilst in April 124s. was secured to Casablanca. Enquiries were circulated in June for loading to the U.S.A. and also Vladivostock, and cargoes were quoted for various destinations for the remainder of the year, but fixtures were not disclosed, although rates had a definitely rising tendency by the end of the year.

Early in the year a few cargoes of sugar were fixed from Brazil, including 90s. to Beirut in January and $17 to Marseilles. In April $25·50 was paid to Antwerp, after which business died down.

No business was disclosed in sugar chartering from Mauritius which was entirely taken care of by requisitioned tonnage, the Government's rate at December, 1939, being 48s 6d.

The same remark applies to Durban sugar chartering, the rate for which in December, 1939, was fixed at 45s. It is interesting to note however that the Government was ready to pay 110s. to the W.C.U.K. in August, and by September had increased their bid to 115s. but without attracting owners. At about the same time $20 was offered to Montreal, but no fixing was disclosed.

Sugar chartering from Queensland was active, British tonnage being fixed in January to the U.K. at 65s. 9d. and neutral boats to Hongkong at 40s. By February, however, 100s. was quoted to the U.K. and May saw the payment of $22 to Montreal, although $19·50 was conceded for this voyage by September, after quotations had fallen to $14·50 in July. By October, however, up to 160s. was mentioned for the U.K. but business was slow to mature. No business was reported from Fiji.

The first half of the year saw some activity in sugar fixing from Java, 70s. being paid in April for Suez and 130s. to Marseilles, whilst in May $32 was secured to Antwerp and 105s. to Port Said. Very little further business transpired, however, although in October quotations for two ports Greece jumped from 125s. to 145s. in a fortnight. Needless to say, there were no offers for this business.

HAITI'S SUGAR CROP.—Haiti in 1939-40 produced 43,812 long tons of sugar, or 3,527 tons more than in 1938-39. As the local consumption is only about 4,000 tons, the balance of nearly 40,000 tons has to be exported. The United Kingdom and France have been the principal customers of late years.

Sugar as a Mono-Export.

Its Development and Consequences.

By C. J. ROBERTSON, Ph.D.

Sugar cane as a mono-culture, occupying almost all the agricultural land, is familiar in many regions, and in some island colonies even occurs when a country is taken as a whole. From the standpoint of general economic policy, however, the cases of sugar as a mono-export are more important. Since the balance of external trade has a critical significance for the financial position of a territory, great reliance on one or two exports means that fluctuations in their fortunes have far-reaching consequences.

When a commodity accounts for over 75 per cent. of the total value of the country's exports it may be regarded as a mono-export. When its value accounts for over 50 per cent. but not more than 75 per cent. it is in this study termed a dominant export, while when two commodities together account for over two-thirds of the total export value and neither fulfils the above criterion of dominance they are here termed duo-exports. Though the setting of such statistical limits may be a matter of personal opinion, the fact that statistical export values are generally not exact reduces the seriousness of this arbitrary character. In the following table Hawaii has been regarded as a special case; though sugar might, according to the definition, be termed a dominant export, pineapple products form a sufficiently large proportion of the exports—over half the value of the sugar exports—to justify Hawaii being placed among the duo-exporters. From one point of view, their joint, and in part unavoidably contemporaneous, production, sugar and molasses may be treated together, but from another, their separate markets, they may be considered separately. Sugar and rum, as optional alternatives in some countries, are perhaps more realistically taken separately. With these possible alternative interpretations in view, the percentages are given, where the trade returns make it practicable, including and excluding by-products.

Of all mono-exports sugar is the commonest, with seven countries, all of them tropical islands. There are also seven countries in which sugar is the "dominant" export, and two in which it is a duo-export. All these countries save British Guiana are also tropical islands. Amongst island sugar producers, in fact, the only important exceptions to the dominance of cane are Java, Jamaica and Trinidad, and in the last two sugar is second only to bananas and oil, respectively, among the exports. Among the factors giving this predominance to sugar is the relative resistance of the cane to permanent damage from hurricanes, many of these islands lying in the hurricane zone. But more important are other factors in the economic and social history of the islands.

Under the Old Colonial System the colonies were estates to be exploited in the economic interests of the mother-country. As a means of attaining the balance of trade aimed at by economic theorists of the time, cane sugar, then one of the most coveted luxury foods, ranked with the precious metals. The cane was introduced into the Caribbean early in the

	Sugar.	Rum.	Molasses	Sugar with by-products.	Second Export.
Mono-Exports.					
Barbados	55·4	0·50	42·0	97·9	
Mauritius	94·7	—	—	94·7	
Antigua	91·8	—	—	91·8	
Réunion	74·8	11·3	—	86·1	
St. Kitts-Nevis	85·0	—	—	85·0	
Martinique	48·9	31·7	—	80·6	
Cuba*	69·7	—	5·6	75·3	
Dominants.					
Fiji	71·8	—	1·0	72·8	Coconut products 15·6
Virgin Islands†	40 3	32·3	—	72·6	Cattle ?
British Guiana	62·9	4·6	3·2	70·7	Gold 7·5
Guadeloupe	42·4	25·1	—	67·5	Bananas 26·3
Puerto Rico	62·5	1·6	1·5	65·6	Cotton manufactures 15·8
Japanese South Sea Islands*	64·1	—	—	64·1	Bonito 8·8
Dominican Republic	56·7	—	5·3	62·0	Cacao 13·1
Duo-Exports.					
Hawaii	57·9	0·1	0·7	58·7	Pineapple products 38·6
Philippines	47·5	—	—	47·5	Coconut products 47·5

Sources: The percentages have been calculated from the data published in the *Economic Survey of the Colonial Empire*, London, H.M. Stationery Office; *International Trade Statistics*, Geneva, League of Nations; trade returns of individual countries. Unless otherwise stated, the data refer to the five years 1933 to 1937 * 1932-36. † 1935-37.

16th century by the Spaniards and into Brazil by the Portuguese. No great range of tropical products was then known, and in any case cane was relatively easy to produce, a factor of increasing importance when scarcity of indigenous labour in the Americas led to the introduction of negro slaves. The sugar islands were especially favoured by the British mercantilists as supplying the mother-country with a product not only non-competitive with home products, but forming one of the most lucrative bases of entrepôt trade, England being the chief supplier of sugar to the continent of Europe. It was the sugar plantations of Guadeloupe that were responsible for the reluctance with which that island, captured in 1759, was returned to France in exchange for Canada.

In a considerable proportion of the countries in the table cane cultivation dates from this early phase of colonial development, particularly in the Caribbean, which accounts for 10 of the 16 countries. In Cuba, now chief of them all, the cane was introduced early in the 16th century, and in Puerto Rico in the middle of the same century. Barbados received the crop in 1640, Martinique in 1650, and British Guiana later in the 17th century. In the two sugar islands of the Indian Ocean—Mauritius and Réunion—commercial cultivation of cane began later, in 1735 and 1784 respectively, but, as in the Philippines, which began to export sugar in 1795, may be said to date from the same phase of colonial policy. In Barbados not only the cultivation but the dominance of the crop dates from this period, in 1685. By that year the white smallholders had been completely squeezed out by the planters, who introduced negro labour to cultivate the land, which, thanks to easy credit and the absence of taxation on unused land, they had been able to concentrate in their own hands. The white settlers of Antigua and St. Kitts suffered the same fate. Though the early development of Martinique did not partake of this capitalistic trend, sugar and coloured labour together had also become dominant there by the end of the 17th century.

The other examples of dominance of sugar belong to the 19th century phase of tropical development. This phase was made possible by the great development of means of transport in the middle of the century. In Cuba, sugar took the place of coffee as the dominant export in the middle third of the century as a result of a chain of events culminating in the emancipation of the slaves in the British West Indies. Subsequently the effects of the abolition of slavery in Cuba in 1880 were countered by the rise of the colono or cane-farming system. As coffee waned in Cuba so did cloves in Réunion, where, with the separation of Mauritius, the final destruction of the island's clove trade by the competition of Zanzibar was similarly compensated by the rise of sugar. The Industrial Revolution, particularly in Great Britain, had already led to the growth of large agglomerations of population, and, with the removal or reduction of import duties, sugar was no longer a luxury. Equally important was the accumulation of surplus capital, for overseas investment, through the banking facilities established after the middle of the century. The attraction of sugar production as a field for the overseas investment of capital on a large scale was to have its most imposing illustration, however, in the territories under United States influence, which happened to include several in which cane was a crop of long standing and where large stretches of lowland gave scope for the advantages of mechanization, while a rich and growing market, completely open, or at least offering very favourable terms, assured large profits. The flow of foreign capital into Cuba after the reciprocity treaty of 1903, reaching its maximum in the speculation of the twenties of this century, resulting in the rapid clearance of forest and planting of cane on much unsuitable land, with little cultivation and practically no fertilizers, is the most striking example of the modern phase of exploitation leading to mono-export. In Hawaii, where cane had been found by Captain Cook, and sugar had been exported since 1837, the cultivation of cane and pineapples increased at the expense of other crops from the fifties, and the two crops shared the benefits of the United States reciprocity treaty from 1875. Similarly, in Puerto Rico the great expansion of sugar production followed the United States occupation, and sugar, admitted duty-free to the United States market, as in Cuba usurped the place of coffee as leading export. Rapid growth of the sugar export from the Philippines also dated only from the United States intervention, though there was a lag, due to doubts as to the political situation and consequent delay in capital investment. On a much smaller scale, in the British Empire, the development of the sugar export of Fiji, with its special connexion with Australia, dates from this epoch. Everywhere is seen remarkable confidence in a single crop on the part of the investor.

The development of more rapid and large-scale means of overseas transport not only brought markets nearer but encouraged the large-scale migration of labour. The rapid expansion of cane cultivation in these lands to meet the demand would not have been possible without the indentured Indian labour of Mauritius, Fiji and British Guiana, and the immigrants of many races into Hawaii, to say nothing of the negroes who came from the more densely populated British islands of the Caribbean to Cuba and Puerto Rico.

In some of the smaller sugar exporting islands dependence on sugar exports came to mean literally mono-culture. Barbados illustrates this even under a régime of small sugar mills. The agricultural land is practically entirely under cane except when fallow or at the season when the land is being prepared

for cane and some catch-crops may be grown. There is not even rough pasture for goats. In Mauritius up to four-fifths of the cultivated area is under cane, while on St. Kitts the fertile land is almost entirely occupied by the crop, the island being otherwise unable to keep a modern factory in operation. As in St. Kitts-Nevis, so in the Virgin Islands of the United States there has been a concentration of cane growing on the single island of St. Croix, while the crop has disappeared from St. Thomas and St. John. On the larger sugar exporting islands the need for obtaining a sufficiently extensive more or less continuous area of cane to feed the large-scale central factories, together with the mechanization of cane cultivation, while it does not involve monopolization of the cultivated area, has led to the absorption of large stretches of lowland. Thus, in Puerto Rico, at the time of the census of 1929, cane occupied 31 per cent. of the cultivated area, the cane farms covering much of the coastal and valley lands and occupying about 40 per cent. of the entire farm area of the island. In this case the expansion of cane has been mostly at the expense of formerly uncultivated land, coffee still occupying about 25 per cent of the cultivated area. In Cuba the factories owned, leased or controlled 30 per cent. of the land area in 1933; much more land than was really necessary for growing cane was occupied as reserve.

The climatic dangers of mono-export, such as drought or hurricanes, are accentuated when the mono-export is also a mono-culture. Some of the sugar islands have a marginal rainfall so that the crop is liable in dry years to suffer severely, particularly in Antigua, St. Croix and Barbados. The drier southern sections of Puerto Rico also suffer from the unreliable distribution of the rainfall, and drought is not uncommon in the Philippines. Most of these sugar lands—Mauritius, Réunion, the Philippines, Puerto Rico, the Dominican Republic, Barbados and the Virgin Islands—are also in hurricane and typhoon zones. To the climatic risk must be added the more permanent danger of soil exhaustion, through long-continued cultivation of cane—especially evident in Martinique—while soil erosion has been accentuated by the clearing of forest to make way for cane, as in Puerto Rico and Antigua. To these climatic dangers are also to be added the attacks of disease and plant pests, both dangers enhanced by the large continuous areas under a single crop, in some cases even under one variety of cane.

The risks of competition from a rival source of supply find a classical illustration in the sugar islands. The competitive conditions of the sugar market, not only as between cane and beet but between the various cane sugar producers themselves have made sugar one of the most dangerous mono-exports. Thus the sugar mono-exporters, and all of the countries with sugar as dominant export or duo-export, except the Dominican Republic, became dependent on quota privileges in the principal or only markets. At one time the sugar industry in the French islands was saved only by the French rum quotas. Duo-exports—pineapples in Hawaii, copra in the Philippines—may, of course, provide mutual support for sugar. When the long-drawn attempts were made to reach international agreement primarily among the countries relying on unprotected markets, it was not without significance that the chief divergence of views was between mono-export Cuba and poly-export Java.

Cuba, forced to rely on the world market for a large proportion of its export, illustrates on the largest scale the social and economic effects of trade fluctuations in a mono-export. When sugar prices are low, the whole life of the country, urban or rural, is depressed. Where there is large dependence on imports for food a depression in such a dominant export may, at least for a time, cause a shortage through lack of foreign valuta. Most of the West Indian sugar countries, as well as Mauritius, must purchase a large proportion of their food abroad. Puerto Rico and Hawaii each depend on imports for three-fifths. Cuba has large import requirements in meat products, condensed milk, eggs and rice. Import of artificial fertilizers also becomes a problem, as in Mauritius.

In addition to the effects of fluctuations, the domination of a country's economic life by a single product has more permanent ill-effects. In the majority of these sugar countries, slavery and the system of indentured labour, together with the absorption of land by the export crop, have left a legacy of under-employment through creating a proletariat of landless casual labour or very poor tenants. Population densities are very high in some areas; Barbados had in 1938-39 from 1700 to 1900 inhabitants per square mile, according as official or unofficial estimates are taken, while in Puerto Rico in 1939, according to PICÓ, there were 1365 per square mile of cultivated land. According to the recent report on labour conditions in the West Indies (Cmd. 6070, 1939), "on the average plantation the main body of labourers can expect to earn wages not more than half the year." These conditions are reflected in the malnutrition and insanitary housing conditions described in recent reports, official and non-official. All Governments in the West Indies are faced with these conditions and the discontents arising from them.

To diminish the dangers of excessive reliance on a single export greater diversification of agriculture has been widely advocated. It meets with many obstacles. Cane may have been found by experience to have been the crop giving the highest income per acre and per labour unit, a factor of fundamental importance in countries so densely populated and so

dependent on food imports as some of the sugar islands. A high standard of economic efficiency as a producer is therefore demanded of any alternative export crop. Technical skill, credits and experienced labour necessary for developing other crops may be lacking, especially where, as in the majority of these cases, the country is a small one. Long dependence on one crop may also have resulted in a certain absence of enterprise. Cuba, it has been said, has "forgotten how to farm." Even if an alternative crop is found there remains the critical problem of finding a market.

It is true that in a number of these countries cane has extended on to less suitable lands. From these it should be eliminated, with the double advantage of raising the unit efficiency of sugar production and freeing land for other crops. The possibility is illustrated by the maintenance of the level of sugar production in British Guiana while the area under cane has steadily declined. Once this restriction of cane to the really suitable lands has been carried out, the essential problem is how best to utilize the remaining land, part of which may be inside the existing cane farms, which may thus have a certain basis for development of mixed farming. This non-cane land may be utilized for two purposes: alternative export crops, should the markets be found for them; and food crops for internal consumption. The Royal Commission on the West Indies recommends mixed farming, especially for the small peasant farmers, who are a considerable section of the West Indian proletariat. Fortunately, some of the smaller sugar islands, St. Kitts and Martinique, for instance, have considerable wild and semi-wild food products, while in Antigua ground provisions are largely cultivated. Fiji and British Guiana have not only considerable food resources but considerable potentialities for developing other exports, the former in its copra, bananas and coconuts, the latter in its mineral and forest resources.

In general, much research both on the technicalities of production and on the economics of marketing has been done, much of it under Government encouragement, for individual crops. A welcome point in the West Indies Commission's recommendations is that closer attention should be paid to the whole question of agricultural policy, in other words to the economy of each country taken as a whole.

Beet Crops of Europe.

THE FOLLOWING ARE WILLETT & GRAY'S NEW CROP ESTIMATES.

	Harvesting Period.	1940-41 Tons.	1939-40 Tons.	1938-39. Tons.	1937-38. Tons.	1936-37. Tons.
Germany	Sept.-Jan.	2,400,000	2,303,812	2,145,141	2,383,659	1,950,527
Czecho-Slovakia	Sept.-Jan.	520,000	519,898	530,474	741,187	709,652
Hungary	Sept.-Jan.	165 000	130,283	127,288	111,015	143,783
France	Sept.-Jan.	238,000	1,033,200	858,892	975,038	892,103
Belgium	Sept.-Jan.	250,000	262,585	194,852	241,816	243,101
Holland	Sept.-Jan.	285,000	245,000	212,580	246,445	244,256
Russia and Ukraine	Sept.-Jan.	2,700,000	2,540,000	2,300,000	2,500,000	1,998,943
Poland	Sept.-Jan.	500,000	430,000	540,378	562,052	458,479
Sweden	Sept.-Dec.	300,000	310,959	292,380	345,194	299,196
Denmark	Sept.-Jan.	245,000	251,992	190,957	250,860	226,200
Italy	Aug.-Oct.	475,000	450,000	398,778	352,111	335,612
Spain	July-Feb.	150,000	82,222	135,000	151,111	239,581
Switzerland	Sept.-Jan.	15,000	15,000	13,000	12,100	9,200
Bulgaria	Sept.-Jan.	38,000	24,716	19,761	32,430	11,821
Roumania	Sept.-Jan.	110,000	145,513	155,446	75,676	71,841
Great Britain*	Sept.-Jan.	485,000	479,046	289,435	377,133	521,944
Eire*	Sept.-Jan.	90,000	57,680	53,891	81,944	89,456
Yugoslavia	Sept.-Jan.	100,000	119,246	85,869	37,370	100,746
Other countries	Sept.-Jan.	168,000	184,700	126,251	150,247	166,468
Beet Total in Europe		9,234,000	9,585,852	8,670,373	9,627,388	8,712,909

* Refined Sugar.

Limitations in Plant Breeding.

The rediscovery of MENDEL'S work at the turn of the century gave an impetus to plant breeding which has formed the foundation of all future work on the subject. Prior to these discoveries, improvements in economic organisms (plants and animals—in the following only the improvement of economic plants will be considered) were made by the practical farmer who had developed "an eye" for favourable variations from type, or by the breeder who crossed varieties but worked on the basis of adding so many "doses" of one or the other variety; first generation $A \times B$, second generation $(A \times B) \times B$, third generation $[(A \times B) \times B] \times B$ and so on. An early experience of the writer's was, in fact, to be handed over a collection of wheats classified as the third generations of crosses derived by this method. As any experienced worker will appreciate the second generation of such a cross will be composed of a mixture of individuals differing from each other to a greater or less extent according to the divergence between the two original varieties. At once the question arose as to which of these varying individuals should be taken as parents for further crossing by B. Here, too, enters the question of the "eye" of the breeder.

In the first enthusiasm of MENDEL'S discovery there appeared to be an open road of escape from this dependence on the personal possession of an "eye" which, if it could be trained, was, nevertheless, a "character" provided by nature. The discovery was simplicity itself, so simple that little technical knowledge appeared necessary for its understanding and application. In simple, non-technical language, it led to the consideration of the organism, not as a unit in itself, but as a complex of unit characters so aggregated that the sum formed an entity—the plant—capable of independent life. Within certain limits it was possible to build up races or varieties differing from each other by the process of adding or subtracting one or more units.

The simplicity appeared to be such that the prospects open to the plant breeder seemed limitless and the idea was popularized by the method of expression; a character might be present, the dominant stage (X), or it might be absent, the recessive stage (x). That some limitation to this process must exist is obvious. What, for instance, would happen when all the characters are absent? The plant would not, as Moses was when the candle went out, be still there. One limitation clearly lay in the capacity of the varieties, when crossed, to yield not merely offspring, but fertile offspring; in other words, the sum of the unit characters must at least form an entity capable of full and independent existence. Characters could, in fact, only be added or subtracted if other varieties were available which respectively possessed or lacked those characters. The extent to which varieties could be built up was limited to the range of characters whose presence and absence was found to pre-exist in the available material of a group of plants which were fertile when crossed *inter se*. In such a group there remained a hard, infrangible core. It is this core which forms the essence of the "species" defined as a group of plants which are fertile *inter se*, though, as the common reference to inter-specific crosses indicates, the word is often applied in a much looser sense. It is in consequence of this fact of the existence of a central core that so many efforts have been made in recent times to discover in out of the way regions of the earth new varieties of the economic plants. Thereby the range of characters at the disposal of the breeder is extended. Of such voyages of discovery the sugar cane offers good examples in the expeditions to New Guinea and other South Sea islands and to the regions extending from the Caspian to China. The former led to the discovery of *Saccharum robustum* with its range of new characters, the latter to new forms of *S. spontaneum* possessing, among other valuable characters, a high degree of cold resistance. Incidentally, the sugar cane affords an example of the less well defined interpretation of the term "species" for, as is commonly known, the above two, with the cane itself, *S. officinarum*, are mutually inter-fertile.

There is another method by which the material at the disposal of the breeder may be extended. Close observation of a "pure race," a group of plants each of which is a combination of the same assortment of characters, may show an odd plant or so which differs in one or more characters from the type; and frequently it will be found that this new character (or characters) is handed down to the offspring. It is an example of the birth of a mutation, the stimulus to produce which remains a secret of nature. Their occurrence is generally rare, though recent work has shown means, particularly by irradiation, to increase the frequency of their occurrence.

If, in the early days following the discovery of MENDEL'S work, the method of transposal appeared simple, later investigations, which have disclosed much of the mechanism by which the transposal is effected, have shown that it may be very complex. Before the mechanism is considered, however, one more general point may be mentioned. The character has been referred to as the unit; but what exactly is a character? Varieties may occur which are distinguished by the colour of the flower, white or yellow, or by the height of the main stem, tall or dwarf, and it is possible to range a collection of plants into two groups according as they fall into one or the other class based on the morphological difference. But this is not invariably the case;

the characters may not be so distinctive and readily determined by eye. Unfortunately, too, it is in those characters which determine the economic value of the plant that the difficulty frequently arises. It is not easy, for instance, to define the taste of an apple or the flavour of tobacco; in fact, the term "character" in its common usage may have and not infrequently has, a meaning bearing little relation to the "character" defined as the unit of plant structure. The above examples are all physical or chemical characters capable of exact determination by appropriate, if intricate, means. A still greater complexity arises in the case of physiological characters which are not capable of such exact measurement, though here, too, the matter may be simple. Susceptibility to a particular disease has not infrequently been found to form a unit character capable of being transposed from one variety to another, though independent of any recognizable morphological difference. On the other hand, it has been found impossible to reduce to any simple formula such a character as purity of the juice of the sugar cane. Partly this may be due to difficulties of exact measurement. The character which constitutes the plant unit is a capacity to respond to a certain environment in a certain way, and environment is a very variable phenomenon both from season to season and from place to place. Even if the character itself is capable of exact measurement, the varied responses of which it is the ultimate expression, are not known with any exactitude. Until the unit characters controlling such responses have been isolated—and the prospect of such isolation is, in many cases, remote—the eye, reinforced by laboratory technique, remains the only means for selecting out the desirable combination of characters, and breeding remains the production, by more or less (often more) haphazard means, of a wealth of material on which the selective art may be exercised.

Whatever their source, it is these characters which provide the material on which the breeder exercises his art, and the character in this sense is a unit which is handed on as an entity from one generation to the next (inherited) and which, theoretically at any rate, can be introduced or removed from the plant complex at will. When attention is turned to the mechanism of the transposal of characters, the mechanism of inheritance, a further series of limitations appear. That mechanism has by now been so popularized that description is hardly necessary. It is the chromosomes of the nucleus of each living cell which carry the physical particles, the genes, which determine what characters shall find expression in the plant. It is the gene which is the physical counterpart of the character.

In general terms it may be said that groups of plants which are interfertile carry the same number of chromosomes in their nuclei. That is the typical case to which, however, there are exceptions; a point to which reference will be made later. Such a group, subject to the caution already given as to the use of the term, constitutes a species. Closely related groups or species, again, are generally found to possess a number of chromosomes which bear some numerical relation to each other; the one a direct multiple of the other or both being multiples of a basic common number. In this lies a suggestion of a common origin and the fact has been used to correct the older systematic classifications based on morphological characters alone.

When attention is directed to the single plant it is found, further, that the number of chromosomes in the nucleus of the living vegetative cells is, again typically, a multiple of 2 ($2n$) and in the nuclei of the generative cells, the pollen and ovum, half that number (n). In fact, in the formation of the generative nuclei a reduction in the number of chromosomes to one-half, from $2n$ to n, takes place, and the full number ($2n$) restored when two such nuclei, gametes, combine in the process of fertilization.

It is hardly necessary to state, for it is common experience, that characters are inherited from both parents, and it follows that, if the capacity to develop that character is a material particle, it must be present as a double dose in the plant body derived from the united gametes, while, in the formation of the gametes a reduction must take place from the double to single dose. This conclusion bears so striking a similarity to the observed behaviour of the chromosomes that it is impossible to avoid the further conclusion that the two are inter-connected. The proof that this is so is too technical to be given here, but it is so overwhelming that it must be accepted as a fact. A material particle, or gene, as it is called, corresponding to the observed character is present in the chromosomes. It requires no deep mathematics to show that, if a plant bearing the double dose (XX) of a gamete corresponding to a particular character be crossed with a plant lacking that character (xx), unless other complexities intervene, the cross (termed the F_1) will possess a single dose (Xx) and will give in equal proportions gametes bearing the gene (X) or lacking it (x), and that these gametes, on uniting to form the second generation, or F_2, will reform the original parental types (XX and xx) in equal proportions and double the number of the type Xx. If in these, as frequently happens, the form XX is indistinguishable from the form Xx, these are termed the dominant form with the form xx recessive. In this is contained the essence of MENDEL's discovery. The character is the unit and a plant is pure or impure with respect to a particular character. The term "pure race" is an expression of approximation only, a convenient method of describing a group of similar plants pure only in respect to all the identificable characters; the existence of a pure plant, one in which the sum total of all characters occurs each in a condition of purity, must be a very rare occurrence.

On this basis alone, breeding becomes a simple process; a process merely of crossing plants severally possessing the desirable characters and selecting from the progeny those having the characters sought. Unfortunately, it early became apparent that matters were not so simple. "Snags" appeared, and the first was this. The number of identifiable characters was found to exceed largely the number of chromosomes. Each chromosome must, therefore, contain more than one gene, and this implied either the linking up of a group of genes, and with those of characters, or a breaking down of the structure of the chromosome in the process of fertilization. It is not possible to follow the technical detail, but the facts which emerge are these. The genes are arranged in a row along the length of the chromosome as beads on a string; each chromosome consists of a group of specific genes and these genes are ranged in a definite order. The complex process involved in the reduction of the number of chromosomes from the vegetative number ($2n$) to the generative number (n) is well calculated to facilitate the exchange of genes.

Consider, as corresponding to the two complementary chromosomes, one derived from each of the parents, two strings of beads, equal in number, but one set blue and the other white. Cut each string in two at corresponding points and re-form them to make two strings each possessing the same number of beads as the original strings but each forming a composite of these; one a row of blue passing to white beads, the other of white passing to blue. Now place in the blue string a red and a green bead. It will be seen that, assuming the position of the cut to be a chance affair, the chance of separating these two beads will be in accord with the distance by which they are set apart in the row. The game may be complicated by making two or more cuts and re-combinations limited only by the interchange of complementary parts. So, robbed of technical language, it is with the chromosomes. Before the reduction from $2n$ to n takes place, the complementary chromosomes, one derived from each parent, become closely associated and an interchange of complementary sets of genes takes place. It follows that genes (or characters) are found to fall into as many groups as there are generative chromosomes. When two genes lie in different chromosomes, their separation is readily effected on crossing with a plant lacking them, and, similarly, they can be brought together if they occur in different plants. Where they lie in the same chromosome, the ease with which they can be combined or separated will be less, but will depend on the distance by which they are separated in the line of genes.

That is an elementary complication; others of a less simple nature occur. For reasons that are not apparent, it may happen that, in the reduction division preceding the formation of the gametes, that in which the $2n$ chromosomes are normally reduced to n, the entire set of chromosomes pass to one gamete. If such a gamete unites with a normal gamete, the product is a cell with $3n$ chromosomes, known as a triploid; if both gametes arise in that manner the resultant cell has $4n$ chromosomes and is known as a quadruploid. Repetition of the process will give cells whose nuclei have higher multiples of n, and the resultant plants form a polyploid series of growing complexity. The phenomenon occurs in nature and it can hardly be doubted that many natural species have arisen in this way, though the stimulus is unknown. In spite of this ignorance, reagents have recently become known, notably colchicine,[1] which stimulate such behaviour.

This is not the only way in which polyploids may arise. The boundary between sterility and fertility when two plants are crossed is not rigid, and not a few cases are known in which the union of the gametes of two plants commonly accepted as belonging to different species results in viable seed which, however, develop into sterile plants, incapable of setting seed. Thus, if a plant possessing $2n$ chromosomes is crossed by another possessing $2m$ chromosomes, the cross will possess nm chromosomes and, through lack of duplication, the intricate reduction process is disturbed. Chromosomal behaviour under such conditions is very varied and it occasionally happens that the phenomenon of duplication described above as leading to polyploidy takes place. If and when two gametes in which this has happened unite, a balanced cell with $2nm$ chromosomes will result, and such balance is associated with fertility.

Tracing the inheritance of any particular gene in such a complex as here arises becomes a practical impossibility. Even in the simplest case, that of a quadruploid, any particular chromosome (and, with it, gene) is replicated four times and that gene may occur in one, two, three, or all of them. It is with such material that the breeder has to work, and, since polyploid forms are not infrequently possessed of a vigour not found in the simpler diploid ($2n$) forms, it is the polyploids which have especial interest.

The sugar cane offers examples of all these phenomena. Not only is it difficult to determine the genes responsible for the valuable characters, but polyploidy and partial polyploidy seem almost to be the rule, the latter accompanied by a greater or less degree of sterility. Though the basic number of chromosomes appears to be 40, varieties are known with multiples of that number, as well as intermediates, exceeding 100. It is essentially a case where the eye and laboratory technique must be relied on to pick out the valuable variety though genetical knowledge will help much to indicate which parents are likely to promise results. Cane breeding, however, has one great advantage; owing to the asexual method of sugar cane propagation, purity of the characters is unnecessary. H. M. L.

[1] *I.S.J.*, 1940, p 163.

Downy Mildew of Sugar Cane.

An account of downy mildew was given by A. F. BELL to the Eleventh Conference of the Queensland Society of Sugar Cane Technologists in 1940, and a brief reference has been made to his account.[1] Additional reference is given in recent numbers of the Cane Growers' Quarterly Bulletin, and it may be of interest to give a fuller account of this disease. It affords a good example of a case in which small beginnings have grown to epidemic size in a country that is more than usually subject to severe attacks of the disease. Ten years has proved ample time to bring about this change in the situation. The causes which lie at the root of this changed situation, as is usual in such cases, are not simple. Two of the more important are given, and are these. The disease is essentially one of well-grown crops, thus belying the general rule that ill-grown and, in consequence, weak plants are more susceptible than those which are healthy and vigorous. It is not without reason, therefore, to associate the spread of the disease with the gradual improvement shown by the Queensland crop which has, in the past 20 years, risen from an average yield of 2 tons to over 3 tons per acre. At the same time a gradual intensification of cane agriculture has taken place; the isolated farms have become contiguous, and that condition, so favourable for a rapid spread of infectious disease, miles of continuous growth, has become established.

The name Downy Mildew owes its application to the disease from the appearance of the fungus as a fine, white, soft mildew which appears on the under side of the leaves under suitable weather conditions. Other features, such as yellowish striping of the leaves, are of a variable nature, and in serious attacks stunting and death result. In its practical aspect the most serious feature of the disease is its capacity to lie dormant, even for months. Normally the fungus penetrates to the growing point where it infects the leaves arising subsequent to infection, but it may merely be localized in the stem at the level of infection. In these latter cases, the subsequent growth will be apparently healthy but the stem will be a source of infection if used as planting material.

The downy appearance on the underside of the leaves is the result of spore formation which takes place at night. The spores are wind-borne and, having no great power of resistance, soon lose viability. The distance to which infection by spore can take place is, therefore, limited; a quarter of a mile is a safe distance. Leaf infection does not take place; the spores must be washed down inside the leaf sheath and make contact with the bud. Growth usually then proceeds to the growing point of the cane; if it does not, the cane plant may produce an infected lateral while the main shoot remains healthy. It is this localization of the point of infection that causes the spread within a field to appear unusually slow for a fungus producing so great a number of spores.

These superficial spores on the leaf surface are not produced in winter; instead, resting spores are produced within the leaf tissues. These fall with the leaf and, being highly resistant, may form a source of infection to the new cane crop. Spread, thus, is again localized if the trash is not transported to another field; extended distribution arises from infected planting material.

Unfortunately, the disease is not specific to cane alone, and in this lies another source of infection. Among the host plants must be counted corn which, owing to its greater succulence, rapidity of growth and less closely bound leaf sheaths, admits of a much more rapid spread of the disease. A measure of the comparative rate of infection is given by the observation that while a single diseased cane plant will infect only a few dozen plants in the course of a season, a whole field of corn may be infected in the course of two weeks. In the corn, too, spores are produced on both surfaces of the leaf, a fact which enhances the dispersal. Sorghums are also attacked but to a considerably lower extent.

In such cases, the usual direction in which control is sought is in resistant varieties. Most of the old standard varieties have proved to carry a certain degree of resistance, but it is an unfortunate fact that the incorporation of wild blood increases the susceptibility of the newer canes, while it is the presence of such blood which is sought to impart resistance to other important diseases.

Among the control measures suggested are care in the selection of planting material which should not be taken from within a quarter of a mile of any diseased plant and, since such plants cannot be determined during periods with dry, cool nights when spore formation does not take place, young cane should be inspected and diseased stools dug out. Diseased fields should also be burnt as a precaution against the resistant spores. Lastly, corn should not be grown in areas in which the disease is suspected.

Of these control measures, that which involves the limitation on the cultivation of maize is the most difficult to enforce in an area of independent farming communities. It is essentially a case for the enforcement of control by an independent body and the establishment of such bodies has been rendered possible under the Sugar Experiment Station Act as amended in 1938 which provided for the creation of Cane Disease Control Boards. In the

[1] *I.S.J.* 1940 p. 377.

Mackay area, where downy mildew is particularly prevalent, the Board is, through its employees, carrying out systematic inspection and destruction of diseased cane. In the Bundaberg area the action of some farmers has largely negatived the action of the Board in that area through insistence on growing maize in spite of the knowledge of the interconnexion between the two crops in the matter of this disease. Control has, therefore, been extended under the Diseases in Plants Act, and it is no longer permissible within certain prescribed areas to grow maize except with the written permission of the Minister or Inspector. If permission is given, certain conditions as to the source of supply of seed are laid down.

In the Bundaberg area cane is the primary and maize a secondary crop. Maize, too, is largely grown for fodder. This raises the question of finding an alternative fodder crop. A natural alternative is sorghum, though the cultivation of this crop is at present in its infancy. It appears, therefore, a question of ascertaining the most suitable variety of which there is a wide range, some more suitable for green fodder than others, and also carrying the capacity of forming ratoons. So far as they have been tested, all varieties have shown no symptoms of the disease. Sorghums serve a purpose, equally with maize, as a component of a legume, pea or bean, mixture grown for fodder.

How downy mildew has come to affect the seedling position is recounted by N. J. KING.[1] The account describes the seedling work at the Bundaberg Experiment Station since the first inception of that work in 1930. An initial handicap was the absence of a local supply of fuzz owing to the failure of the arrows to set seed. Supplies had in consequence to be brought from northern Queensland. Improvements in technique, in the establishment of an irrigation system in 1935 and of heated glass-house in 1937 followed. At the commencement the three standard varieties were D 1135, M 1900 and Q 813, and the disease problem was limited to gumming. The first point on which information was required was the varieties which would serve best as parents in consideration of their capacity to hand down resistance to gumming. This slower method was, however, anticipated by the distribution of POJ 2878 in 1933 together with POJ 213, and, in 1934, of Co 290, POJ 2725 and POJ 234. Thus five varieties, all superior vegetatively to the old standards and with a high resistance to gumming, were rendered available.

With this alteration in the situation the problem changed. Queensland demands certain combinations of qualities in her canes which are absent elsewhere. Her standard canes were the sweetest in the world. A feature, not required in Indian or Javanese canes, was a capacity to ratoon well. Further, if gumming was, at that time, the most important disease, three others were the cause of some concern—mosaic, Fiji and downy mildew. Of the above quoted POJ canes, POJ 2878 is resistant to gumming but highly susceptible to the other two; POJ 213 is resistant to gumming and Fiji, but highly susceptible to mosaic and downy mildew; while POJ 2725 is resistant to all but Fiji disease. As a result 1938 saw a wholesale spread of Fiji and downy mildew in the Bundaberg area, whilst seedlings till then considered very promising as being resistant to gumming as well as possessing valuable agricultural characters, had to be discarded through their failure to resist Fiji and/or downy mildew. Meanwhile, owing to its valuable agricultural characters, POJ 2878 has set a new standard against which any new variety will be measured by the agricultural community.

It is not surprising, therefore, that this reorientation of the breeding problem has materially delayed the issue of practical results from the work. It may be said at once that the ideal cane, one which is resistant to all the above diseases as well as possessing agricultural qualities equal to the best of the present commercial canes, has not been and may never be obtained. The nearest approach so far obtained to that ideal is Q 25. This cane is a product of POJ 2875 × HQ 409; the former a cane which has attained prominence in no country, the latter a seedling raised at Hambledon and still cultivated in the area round Townsville. Q 25 is resistant to gumming and downy mildew, but susceptible to mosaic and Fiji, the former character being its most important advantage at the present time. It is a thick cane and a good striker and ratooner with stalks slightly spreading but nevertheless standing up well. It does not form large stools and covers in slowly. Production figures in comparison with Co 290 are available. Over four crops between the years 1936 and 1939 Q 25 yielded 152 tons per acre at an average c.c.s. of 16·12 as compared with 119·6 tons at an average c.c.s. of 14·35 for Co 290. These figures are very promising but the variety has still to be proved as to its capacity to stand over. One pleasing feature is the fact that, in 1939, a free-arrowing year, Q 25 showed no signs of arrowing.

This is the position attained by Q 25, the most promising of the seedling canes, and arrangements are being made for its distribution among the farmers of the Bundaberg district. It is not yet placed on the approved list and its growth requires authorization, seed cane being obtained through the Disease Control Board. It is not permissible for farmers to obtain seed through those farmers who have already grown the variety under agreement with the Bureau. These facts give some indication of the care now exercised for the protection of the sugar cane crop of the Queensland industry.

H. M L

[1] *Cane Growers' Quarterly Bulletin*, 1940, **8**, p. 29.

The Queensland 1939 Sugar Crop.

Bureau of Sugar Experiment Stations Report.

From the 40th Annual Report of the Bureau of Sugar Experiment Stations, Queensland, for the year ending June 30th, 1940 (as prepared by Mr. H. W. KERR, the Director), we take the following particulars of the 1939 sugar crop in that country.

Cane.—The total area harvested for milling purposes in 1939 was 261,047 acres, which compares with 251,064 in the previous season. Of this acreage, 102,759 was under plant cane, 137,590 under ratoons and 20,698 acres was standover cane. The yield of cane per acre crushed averaged 23·14 tons, ranging from 29·5 in Lower Burdekin to 15·0 in Proserpine, and the average sugar yield (94 n.t.) was 3·41 tons, ranging between 4·71 and 2·36 in the same respective districts. Both these figures for 1939 establish new records for Queensland, and the yield of sugar has now exceeded three tons for four consecutive years. The average acreage farmed by individual cane planters ranged from 48 acres in the Cairns-Townsville area to 8 in the Nambour-Beenleigh area, the average for the whole State being 32, as compared with 31 in 1938.

Sugar.—The yield of raw sugar in Queensland for the 1939 crop was 891,422 tons[1] of 94 n.t. This was easily an all-time record tonnage, exceeding that of 1938 by some 113,000 tons. Of this quantity, 351,267 tons was produced in areas north of Townsville, and 540,155 tons, or 60 per cent., in areas to the south. Thus the progressive upward trend in production in the central and southern areas of the State has been maintained. These improved results are due in differing degrees to the following causes: Superior cane varieties, elimination of loss due to disease, larger areas cultivated, and the adoption of better methods of cultivation and more rational use of manures.

Table I gives the crop statistics for Queensland for the past ten years, while Table II summarizes production and consumption figures and sugar values for the same period.

Manufacture.—The proportion of the 1939 sugar crop manufactured in Queensland which was required for consumption and use in the Commonwealth was declared at 49·85 per cent. and that for export at

TABLE I.

SHOWING ACRES CULTIVATED AND HARVESTED, YIELDS OF CANE AND SUGAR, ACRE-YIELDS AND QUALITY OF CANE, 1930—1939.

Year.	Acres. Cultivated.	Acres Harvested.	Total Yields: Cane. Tons.	Total Yields: Sugar. Tons.	Yields per Acre: Cane. Tons.	Yields per Acre: Sugar. Tons.	Tons Cane to 1 ton Sugar. Tons.
1930	296,070	222,044	3,528,660	516,783	15·89	2·33	6·83
1931	309,818	233,304	4,034,300	581,276	17·29	2·49	6·94
1932	291,136	205,046	3,546,443	514,085	17·30	2·51	6·90
1933	311,910	228,154	4,667,028	638,734	20·46	2·80	7·31
1934	303,916	218,426	4,269,991	612,570	19·56	2·80	6·97
1935	314,700	228,515	4,220,267	610,326	18·47	2·67	6·92
1936	338,686	245,152	5,171,516	744,261	21·10	3·04	6·94
1937	348,840	249,683	5,132,934	763,325	20·56	3·06	6·73
1938	347,199	251,064	5,342,085	778,136	21·28	3·10	6·87
1939	*	261,047	6,038,821	891,422	23·14	3·41	6·77
True average for 10 years		234,244	4,595,205	665,092	19·62	2·84	6·91

* Not available.

TABLE II.

Year.	Total Sugar Production at 94 n.t. Tons.	Tons Sugar Exported* Tons.	Average Australian Price £	Average Export Price. £	Average Price, No. 1 Pool Sugar. £	Average Price, *all* Sugar £
1930	516,783	203,605	27·00	8·30	19·70	†19·50
1931	581,276	291,802	27·00	9·40	18·30	18·00
1932	514,027	189,733	25·00	8·30	19·30	18·80
1933	638,734	305,687	24·00	8·00	17·20	16·20
1934	612,570	277,336	24·00	7·60	16·50	15·50
1935	610,326	298,202	24·00	7·90	16·90	16·20
1936	744,261	409,400	24·10	7·95	17·10	15·20
1937	762,794	430,523	24·00	8·30	17·55	15·30
1938	776,810	443,386	24·00	8·20	16·95	15·10
1939	890,896	515·792	23·60	10·40	17·00	‡15·75

* Bagged Sugar. † Peak Year Scheme first operated in 1930. ‡ Revised Mill Peak schedule first operated in 1939.

[1] This is slightly in excess of the figure quoted in Table I as it includes local sales which are additional to that quantity acquired by the Sugar Board.

50·15. These proportions are exclusive of the "excess" sugar produced by mills in excess of their allotments under the Peak Year scheme; the excess sugar produced in 1939 was 168,520 tons, as compared with 163,943 tons in 1938, and 183,869 tons in 1937.

Prices.—The price payable for the sugar required in Australia was declared at £23-12-6 per ton of 94 n.t. The net value per ton of 94 n.t. sugar sold abroad was £10-7-6, a figure which is £2-3-3 per ton higher than the 1938 one. The average price paid to those Queensland mills which did not produce "excess' sugar was £16-19-7 per ton, or 6d. more than in 1938. The average value of all sugar was £15-15-3, which is the highest recorded since 1935. The total value of the 1939 crop was £14,042,000— an all-time record and higher than the 1938 value by £2,304,000.

Molasses.—During 1939, 23,084,783 gallons of molasses was produced, which compares with 20,286,191 gallons in 1938. This quantity was disposed of as follows:—

Sold to distilleries	9,581,241
Burnt as fuel	3,834,653
Used or sold for feed	4,727,170
Sold for other purposes	188,889
Used as manure	4,295,289
Run to waste	457,541
	23,084,783

The 1940 Sugar Crop

The growing season for the 1940 cane crop was one of alternating extremes. The dry Spring months of late 1939 were followed, in general, by excessively heavy wet-season rains, so that water-logging of fields of backward cane was common, and handicapped the crop. The cyclone season also left its mark. The magnitude of the estimated crop was therefore surprisingly good; preliminary estimates put it at 5,857,700 tons of cane, a figure substantially below the actual yield for 1939 but still very much higher than normal. By November it was doubtful whether this tonnage would be realized, due to the heavy arrowing of the crop in most districts, combined with lighter crop yields following a very dry autumn; on the other hand, the crop seemed to promise a high sugar content, and this factor was bound to compensate in some measure.

Allowing for that proportion of the cane crop that will probably be allowed to stand over until 1941, estimates are that some 810,000 tons of raw sugar will be manufactured. Such a tonnage, if realized, would be second in magnitude only to the record production of 1939—891,422 tons. In addition, N.S.W. mills were expected to crush some 310,000 tons of cane, from which approximately 39,000 tons of sugar may be expected. The estimated total Australian cane sugar production for 1940 may therefore be placed at 850,000 tons, to which must be added some five or six thousand tons of beet sugar produced at Maffra, Victoria.

The Economic Outlook.

The 1939 crushing season (said Mr. Kerr) was launched in an atmosphere of uncertainty. The cane crop was the largest ever produced, and with the operation of the international export quota scheme it appeared that less than 50,000 tons of excess sugar could be acquired and disposed of, over and above the basic mill peak aggregate of 737,000 tons. The probable unmarketable excess was thus some 100,000 tons of raw sugar. At this period the grave international situation was rapidly deteriorating, and cumulated in the declaration of war in September, 1939. This brought about a substantial change in the economic position so far as the British Empire was concerned. The British Government embarked on a policy of Empire purchasing which ultimately gave the Australian sugar producer the unexpected opportunity for disposing of his entire 1939 production, the transaction being of course contingent upon the availability of shipping. The net export value realized for sugar sold after the outbreak of hostilities was about £10-10-0 per ton, substantially better than the average price in recent years.

While the war was thus initially responsible for easing what would doubtless have been a most difficult position, there are definite indications that the continuance of hostilities may create just as difficult problems for the future. The tonnage of cane in 1940, which is expected to have been available for manufacture, is capable of yielding well over 800,000 tons of sugar, in spite of the less favourable growing season experienced. While the Empire purchasing plan may be able to absorb the entire volume of Australian production during 1940, the availability of shipping is less certain. It was anticipated that the sugar manufactured early in the crushing season could be got away without difficulty, but that a large proportion of that made later would have to be held in storage for some months. Many of the mills were forced to store portions of the 1939 crop till the autumn of 1940, and steps have since been taken to provide increased storage capacity for this and subsequent years.

The industry recognizes that the outlook is obscure, and the need for rationalization of production is probably more acute than ever before. In most mill areas a sincere effort has been made to implement the 1939 amending regulations which make provision for the formulation of a scheme to control production on individual farms within the limits of the present mill peak tonnage. Yet to devise a basis which is acceptable to the large majority of cane growers in any area is, of course, a task of some magnitude. However, it is encouraging to be able to record that something has been achieved in this respect, for while a number of mill areas have allotted peak tonnages of cane (or sugar) to the individual suppliers, others have favoured control on a net acreage basis. The future alone will show which plan possesses the

greater merit. Admittedly, any form of production control is irksome to the primary producer. Even though he may have no special desire to increase his individual production, there exists the factor of intensification of agricultural methods which makes for a steady but progressive increase in acreage yield. While it may be urged that the area cultivated should be reduced in proportion to the increased production per acre, this would be offset by the natural gain in regional farming population from year to year which normally prefers to be absorbed into sugar production rather than to migrate to an area where other forms of primary industry are enjoying no greater measure of stability.

Such considerations have induced exploration of the possibilities of utilizing surplus production for purposes other than human consumption, as well as providing a safety valve in the event of the closing of the present overseas distribution channels in the course of post-war adjustment. The scheme of diverting cane juices or syrups to the production of fuel alcohol seems to offer something in this respect.

The Multifeed Dorr Clarifier.

By G. A. N. WOODCOCK.

During the past 20 years the Dorr Clarifier has been generally adopted as standard equipment in modern sugar factories, and installations for either Simple or Compound Clarification are now to be found in no less than 30 sugar-producing countries. In the course of these two decades great strides have been made in both the theory and practice of clarification (defecation), and the Dorr has been continuously improved as experience dictated. This largely accounts for the fact that about 95 per cent. of the continuous cane juice clarifiers in use to-day are Dorrs.

The introduction of new cane varieties, particularly some of the POJ hybrids, brought along new clarification problems, and led to more intensive research into the fundamentals of defecation, which hitherto had been taken for granted. Clarification of cane juice involves both chemical and physical operations : first, coagulation and precipitation of soluble non-sugars by the application of heat and the addition of lime, with or without other chemicals; second, the flocculation or consolidation of the now insoluble particles ; and last, after they have settled out, their final removal, so that a sucrose solution of maximum clarity and purity may be delivered to the evaporators.

The preliminary treatment, heating, liming, etc., varies greatly, and no one method is likely to produce optimum results under all conditions. It is, however, very important that every effort be made to adapt the procedure to changing local conditions and so obtain the best possible reaction at all times. Subsequent treatment, though it may greatly assist this reaction, must never be expected to replace it.

The two basic factors affecting flocculation are the tendency of the particles of a precipitate to attract and collide with one another and their tendency to adhere to each other after such collision. The adhesion factor is influenced by the preliminary treatment, i.e., the adjustment and control of *pH* and temperature, a matter under local control. The collision factor is influenced by motion within the system and the time element. These latter are general rather than special conditions, and something could be done to control them in a general way. The Dorr was accordingly modified by enlarging the original small diameter "feed well" into a "flocculating cell" having the same diameter as the rest of the clarifier.

As no clear juice was removed from this chamber or compartment any more than it was from the small feed well the time element or detention period was considerably lengthened, thus allowing a more complete chemical reaction. The addition of vertical vaned panels to the rotating scraper arms in the "flocculation cell" multiplies enormously the chances for collisions between the particles. These distinct improvements were introduced with excellent results but the steadily increasing percentages of the more refractory juices continued to cause trouble by reducing the capacity of existing clarifiers.

Attention was then focussed on the fact that in the regular tray type of thickener, where the mud from each tray is to some extent intermingled with the feed to each lower tray in turn, there is bound to be some re-dispersion of the mud particles. Experimental work has definitely proved that settled flocs, if re-dispersed, will not re-form in flocs of the same size, nor will ever re-settle so completely nor so fast; and also that the finer the particles are, the more pronounced does this become. Due to the much greater re-dispersion occurring with the more slimy settlings of the POJ cane varieties, the Multifeed Dorr was designed so that the mud and juice, once separated, would remain so; this also meant that the feed to all the trays would be of identical composition. In this machine the old centre shaft has been replaced by a central tube with partitions providing for separately conveying the flocculated

juice to the lower compartments and the mud from the trays to the mud thickening compartment.

Reference to the illustration (Fig. 1) will make the following description plain: The interior of the Multifeed Dorr is divided into a flocculating cell *A*, a mud thickening compartment *B*, and tray compartments *C*. The number of tray compartments and the diameter of the tank depend upon the capacity required and the factory space available. The mechanism consists of a rotating centre tube *D* with partitions for the passage of the flocculated juice *J* to the lower compartments, and passage of settlings *K* from the tray compartments to the lower mud thickening compartment.

Two arms in each compartment are rigidly attached to, and rotate with, the centre tube. Carefully designed extensions form a part of the arm assembly and gently move the sediment in a spiral path from the outer edge of the trays, to the mud discharge opening in the centre tube. The flocculating cell is provided with vaned panels *E* fastened to the scraper arms and rotating with them. The gentle agitation of the incoming treated juice by these panels assists in the formation of rapidly settling flocs. At the juice surface in the flocculating cell are located spiral skimmers *L* and hanging blades *M*. The skimmers move the foam towards the periphery of the cell, where it is discharged into the foam canal *O* by the hanging blades.

Rotation of the centre tube and the mechanism attached thereto is obtained through a specially designed reduction unit *F*, the tube being bolted to a worm wheel which is supported on ball bearings. Radial and thrust loads from the worm gear and mechanism are carried by ball bearings in the reducer unit, all parts of which operate in an oil-bath, ensuring uniform and smooth performance. The Dorr Multifeed Clarifier can be supplied with either steam or electric drive, the power required being 2 H.P. for the smaller and $4\frac{1}{2}$ H.P. for the larger sizes. Actual power consumption is often only 50 per cent. of the connected horse-power.

Clarified juice is withdrawn from the upper portion of each compartment *N*, the flow being regulated by adjustable sleeves in the clarified juice overflow box *G*. The settled solids from the tray compartments are discharged into the bottom compartment where additional thickening takes place, while the thickened mud is continuously removed by the Dorrco Pump *H*, which is provided with an adjustment to permit variation of the volume of the discharge. The settled solids are thus continuously removed by positive mechanical means in a manner providing no opportunity for either accumulation or fermentation. The mud withdrawn occupies less than one-half the volume of the settlings discharged from ordinary defecators, as the quantity of juice remaining in the mud is relatively small.

Like all its predecessors, the Multifeed Dorr is extremely well insulated, and there is a difference of only about 2°C. between the temperatures of the feed and the clarified juice. The advantage of this in steam economy at the evaporator is obvious. As the hot thin-juice can be held over in the Dorr for a day or longer without appreciable drop in purity, the necessity of working it up at the weekly shut-downs is avoided. This means, not only that the evaporators can be shut down almost simultaneously with the mills, but also that they can be started up with the mills, as clarified juice will flow from the Dorr as soon as the feed to it re-commences. There is therefore less need to blow exhaust steam through the roof, as is usually done while open defecators are being filled. Provision is, of course, made for completely emptying the clarifier for liquidation.

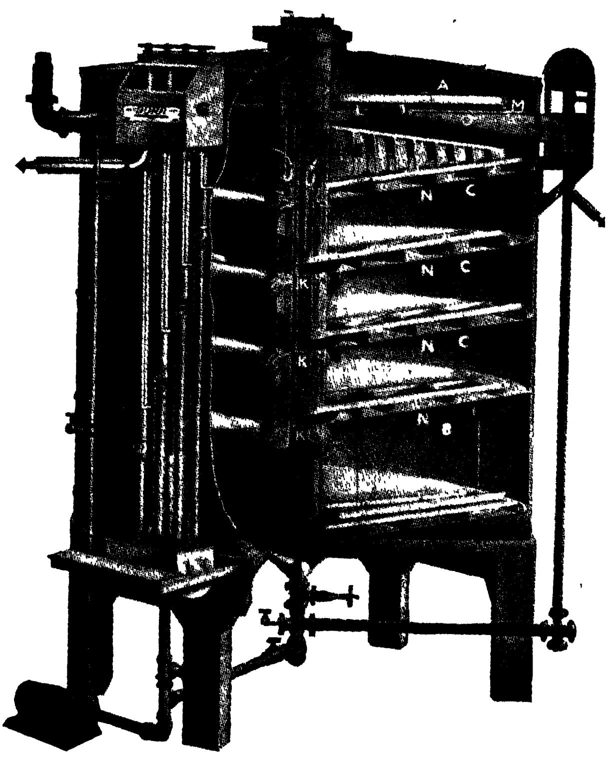


Fig. 1.

Advantages of the Dorr Clarifier over the out-of-date system of open defecation are so well known, and have been so thoroughly demonstrated in every sugar-producing country, that only a very brief

summary need be given here: There is a great saving in floor space, in mud filtering surface, in labour and in fuel. A continuous flow of uniformly clean juice and denser mud, at higher temperatures together with the smaller volume of each in process, leads to more efficient boiling-house work, cleaner sugars, lower filter-cake loss, and more rapid processing throughout, with all the attendant savings.

The new Multifeed Dorr has been proved by carefully conducted comparative tests in Cuban mills to have between 30 and 40 per cent. greater capacity than the old type, but a 25 per cent. increase has been adopted as a conservative figure in determining the new ratings. This means that smaller machines may be specified for a given tonnage with corresponding economy of space and money.

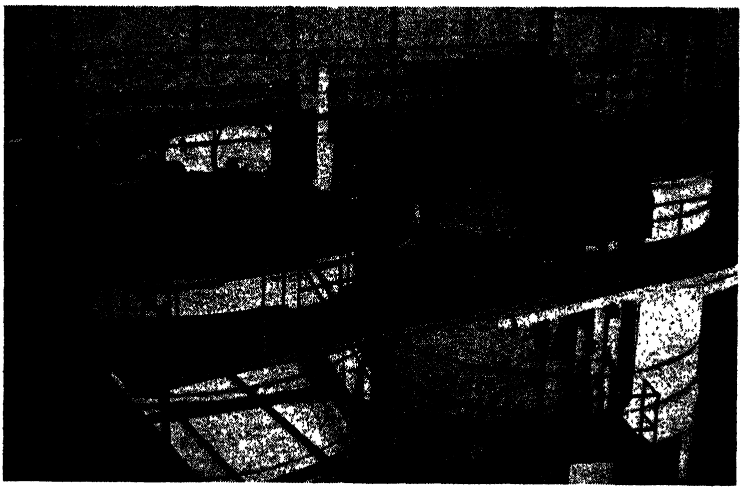


Fig. 2.—Dorr "Multifeed" Clarifiers at Central Santa Juana, Puerto Rico.

The Multifeed Dorr is particularly suited for Compound Clarification, permitting as it does of a more compact and less expensive installation. The illustration (Fig. 2) shows such an installation, the convenience of operation and supervision being at once apparent. The Primary Dorr, the larger of the two in the photograph, receives the juice from the crusher and first mill together with the clear overflow from the smaller or Secondary Dorr, the mixture having been previously heated and limed to give optimum settling. The clarified mixed juice is delivered to the evaporators while the primary mud is mixed with the feed to the Secondary Dorr. This feed is composed of the secondary or maceration juice, from the second mill, which after addition of the primary mud is given the appropriate lime and heat treatment.

This dilute juice contains by far the greater proportion of the colloidal and lighter impurities, and it is an immense advantage to be able to give it the treatment best suited to it, which invariably differs considerably from that which produces the best results in the primary juice. The secondary mud is sent to the filter station and, as the higher sucrose content of the primary mud has been reduced by the leaching effect of the lower density secondary juice, the feed to the filters has a lower sucrose content than is usual with simple clarification. That this must be so is obvious from the fact that the Brix and purity of the secondary juice is several degrees lower than that of the mixed juice from which the mud is settled out in simple clarification. The mud from the Dorr is of a granular consistency which greatly facilitates filtration, and the result of these two favourable characteristics results in an appreciably lower loss of sucrose in the cake.

Compound Clarification installations have been made under widely varying conditions in some 20 different countries, and all have shown increased sugar recoveries of from 1 to 2 per cent. Better elimination of colloidal and other impurities results in freer boiling massecuites with quicker and more complete exhaustion of syrups, thus reducing in-boiling with all its disadvantages. The less viscous massecuites purge more easily and so increase the capacity of the centrifugals, produce a cleaner and dryer sugar with better keeping qualities than sugar made from juices clarified by the old methods. Compound Clarification with the new Multifeed Dorr Clarifiers offers an excellent means of overcoming the problems created by the introduction of the hybrid canes.

EMERGENCY SUGAR SUPPLIES FOR U.S.A.—The President of the American Sugar Refining Company recently pointed out that, in respect to sugar's part in the American national defence programme, ample supplies seemed to be assured at reasonable prices. Thirty per cent. of the total consumption comes from sugar grown in the continental United States. The other 70 per cent. comes from Cuba, Puerto Rico, Hawaii and the Philippines. The supply available from these islands assures the country its sugar supply if production and shipping are unhampered. In fact there are large surpluses, actual and potential, especially in Cuba, resulting in part from the expansion programme of the last war; any failure of supply from the Philippines, for example, could be replaced without difficulty from Cuba alone. In other parts of the world sugar surpluses existed at the beginning of the present war. While the latter has upset some production, it has also reduced much consumption.

Chemical Reports and Laboratory Methods.

Synthesis of Sucrose by the Sugar Cane Plant.

CONSTANCE E. HARTT. *Reports of the Hawaiian Sugar Technologists, 2nd Meeting,* pp. 113-116.

In the Enzyme Laboratory of the Hawaiian Sugar Planters' Association, the processes of the inter-conversion of glucose and fructose and the formation of cane sugar are being studied, using detached blades, entire plants, etiolated shoots and excised roots supplied with simple sugar in the dark. Results recorded so far may be summarized briefly as follows.

Supplying detached blades with both glucose and fructose hastens and increases the formation of cane sugar in the dark, compared with supplying only one of the simple sugars. Detached blades can continue to form sucrose from glucose for nearly two weeks, reaching over 16 per cent. cane sugar on the dry-weight basis. Temperature affects the absorption of simple sugar, the inter-conversion of glucose and fructose, and the formation of sucrose.

The absorption of simple sugar is much the same at 6 and 20°C. but is increased considerably from 20 to 40°C. The inter-conversion of glucose and fructose does not take place at 6°C.; it keeps pace with the formation of sucrose at 20 and at 30 to 40°C. it exceeds the synthesis of sucrose. The optimum temperature for the formation of sucrose by detached blades supplies with simple sugar in the dark was found to be 30°C.

Experiments reported previously[1] indicated that although neither light nor chlorophyll is required for the formation of cane sugar from glucose in leaves of plants which had been grown in the light (albino leaves with a hereditary lack of chlorophyll), yet etiolated plants (plants lacking chlorophyll because grown in the dark) are able to make only very small amounts of sucrose from the glucose supplied.

These experiments were repeated. When supplied with glucose in the dark, the green and albino blades made practically the same amount of sucrose. Young etiolated and green shoots of the same age were placed in 5 per cent. glucose in the dark for 24 hours. The etiolated shoots increased 1·07 per cent. sucrose on the dry-weight basis, while the green shoots increased 2·06 per cent. These experiments indicate that the "sucrose-synthesizing mechanism" does not require chlorophyll; and that it does not require light for its action, but may require light for its formation.

In the Annual Report for 1938 the statement was made that when entire plants of the variety H 109 were supplied with 5 per cent. glucose in the dark for 48 hours, the roots absorbed glucose and made sucrose, but there was no evidence that any of the glucose or sucrose went into the stem and leaves. This experiment was repeated with similar results. In another experiment the roots of one series were trimmed about 2 cms. behind the tips, the tips being discarded. Entire plants were supplied with 5 per cent. glucose for 48 hours, one series with intact roots and one series with trimmed roots.

The entire roots absorbed more glucose than the trimmed roots and gained 4·2 per cent. sucrose on the dry-weight basis, whereas the trimmed roots gained only 0·7 per cent. sucrose. Of the glucose absorbed by the intact roots 52 per cent. was converted into sucrose, whereas of the glucose absorbed by the trimmed roots only 38 per cent. was converted into sucrose. Trimming the roots decreased not only their ability to absorb glucose but also their ability to form sucrose. This might indicate that part of the "sucrose-synthesizing mechamisn" is supplied by the root tips.

These studies with etiolated plants, entire green plants and excised roots indicate several important characteristics of the "sucrose-synthesizing mechanism." This mechanism may require light for its formation but not for its action; it does not require the presence of chlorophyll; it may, in part, be formed in the leaves and move down to the roots, and it is somehow rendered less active if the root tips are removed. In short, the mechanism seems to possess some of the characteristics of a vitamin or a hormone.

To examine this possibility, vitamins and hormones were used in synthesis tests. Again, the excised roots, not aerated, made almost no sucrose. The ability of aerated excised roots to make sucrose from glucose was increased by each of the following factors, in decreasing order: vitamin B_2 (riboflavin), vitamin C (ascorbic acid), sodium phosphate (NaH_2PO_4), vitamin B_1 (thiamin chloride). The increase in synthesis induced by riboflavin was considerable. Excised roots supplied with riboflavin made much more sucrose than the attached roots without riboflavin.

Riboflavin, ascorbic acid and thiamin chloride are all normal constituents of green leaves and are supposed to be supplied to the roots by the leaves. They are highly active in the metabolism of both plants and animals, but much remains to be learned of their functions. The results herein reported constitute evidence that these vitamins function directly or indirectly in the synthesis of sucrose from glucose. These studies are being continued for the purpose of learning more about the "sucrose-synthesizing mechanism" of the sugar cane plant.

1 *Hawaiian Planters' Record*, 1937, **41**, pp. 33-46; see also the Annual Report for 1938.

Conductometric Determination of Ash. E. D. JENSEN.[1] *Technical Communication No. 6, Bureau of Sugar Expt. Stations, Brisbane*, pp. 1-13.

KELLY and NEWMAN[2] have demonstrated in Queensland that the estimation of ash from direct conductivity measurements yields results of sufficient accuracy when applied to the products of one factory, but it is not known whether a single relationship between conductivity and ash exists for all Queensland sugars. Accordingly this research was undertaken

Experimental.—Apparatus used consisted of a Cambridge 10-metre slide-wire bridge having ranges centred about 5, 50 and 5,000 ohms. It was supplied with A.C. at 5 volts from the secondary winding of the Sugar Bureau *pH* Meter,[3] the galvanometer terminals of the bridge being connected, one to the control grid and the other to the earth of the meter. Thus the Wheatstone network constituted the grid leak resistance of the control valve of the meter, and any out-of-balance voltage in the bridge was applied directly to the meter, causing a deflection on the indicating dial. Changes of 1 ohm in 5,000 could be detected; and, while the accuracy thus obtained is not high compared with that of precision assemblies, it was sufficient for the purpose in view.

In determining the cell constants, the electrodes were coated with platinum black,[4] conductivity determinations being then made with standard solutions of 0·001-*N* and 0·002-*N*. Sugar solutions of 1 per cent. were used, this concentration having a resistance yielding a balance about the mid-point of the 5,000-ohms range of the bridge. It was found that a common temperature coefficient of resistance could be applied to the solutions used, and 20°C. was adopted at the standard temperature. In the formula $C_t = C_{20}\,[1 + \alpha\,(t - 20)]$ α, the temperature coefficient was found to average 0·0254 for eight solutions from different factories.

Values for gravimetric ash (using the double sulphate method as standard) and conductivity at 20°C. were plotted for each of eight factories, the plots being such as to enable linear relationships to be postulated, so that the equations were of the general form : Ash $= \dfrac{20 - a}{b}$ a being the intercept on the conductivity axis, and b the slope of the line. At zero ash a conductivity remains, as expressed by a, equal to that of the water used in preparing the solutions; a could, of course, be eliminated by applying a subtractive correction to the measured conductivity of each solution, giving a formula of the general form : Ash $= \dfrac{C}{b}$

Results.—In carrying out the gravimetric ash determinations in duplicate, in 46 cases out of 52 the differences in duplicates did not exceed 0·02, and only one exceeded 0·05 per cent. ash. Regarding the conductometric ash determinations, 42 out of 52 duplicates agreed within 0·02, and again only one exceeded 0·05 per cent. ash. Therefore, from the point of view of precision alone the conductometric method is not inferior to the gravimetric, besides being much more rapid. As for the differences between the gravimetric and conductometric ash values, in 40 out of 52 tests these did not exceed 0·02, and only four exceeded 0·05 per cent. ash. It, therefore, follows that if the conductometric determination of ash be adopted, not only will the standard of accuracy be at least maintained, but a smaller proportion of the chemist's time will be devoted to the work.

It is necessary that each factory should prepare for itself at the commencement of the season a curve relating conductivity and chemical ash, using a representative group of sugar-house products covering the range likely to be encountered in routine work. It should also be mentioned that the apparatus used in this research, while sufficiently precise for the work, could not be considered entirely suitable for a factory laboratory, particularly as instruments are available which in a compact and robust form combine at least equal accuracy with greater convenience in manipulation.

Losses known and unknown in the Sucrose Balance Sheet. J. RAULT. *Proc. 14th Cong. South African Sugar Tech. Assoc.*, 1940, pp. 151-154.

Undetermined losses do without doubt exist, and steps taken to reduce them, as well as the other known losses in the bagasse, the filter-cake and the molasses, will definitely prove remunerative. In South African factories between the years 1928 and 1939, the loss in the bagasse has been reduced by 2·86, that in the filter-cake by 0·92, and that in the molasses, including the undetermined, by 3·42, a total of 7·20 per cent. in the overall recovery.

It is not necessary to use formulae to confirm the belief that the large losses taking place in the boiling house in years past are not merely losses in high purity molasses. They are to a large extent attributable to those undetermined losses so difficult to locate when the factory control has had to rely on inferential figures in place of the positive weighing of products.

It is possible to bring definite evidence of the effect of undetermined losses on the overall recovery by presenting the detailed sucrose balance sheet of the author's factory during the past five years. It is evident from these figures (as per cent. sucrose in cane) that the most significant improvement consisted in reducing the undetermined losses, the known losses remaining more or less constant.

1 Assistant Chemist, Fairymead Mill, Queensland. 2 *I.S.J.*, 1939, p. 394. 3 *I.S.J.*, 1934, p. 190.
4 As described in "Soil Analysis" by C. H. WRIGHT (Murby, London).

In order to obtain a better insight into these unknown losses (which have been reduced, but not eliminated), the control was improved by the addition of a syrup scale, which revealed certain anomalies that could not have been detected previously. It was thus possible to separate the unknown losses as those taking place up to the pans and those occurring during boiling and curing.

	1935.	1936.	1937.	1938.	1939.
Lost in bagasse ..	5·48	5·38	5·20	5·21	5·35
,, filter-cake	0·54	0·46	0·43	0·48	0·41
,, molasses ..	6·22	7·02	7·36	7·30	6·36
Undetermined loss	4·59	3·46	2·32	1·53	2·11
Recovered in bags	83·17	83·68	84·69	85·48	85·77

In the course of the past season when a definite improvement in boiling house technique and cooling equipment resulted in a lower molasses loss, it was puzzling to find a setback in the unknown losses, 75 per cent. of which were taking place during boiling and curing and 25 per cent. up to the pans. By a process of elimination, the location of these losses was narrowed down to the rich boilings.

This diagnosis by technical accountancy was subsequently confirmed by placing detector samplers on the vapour pipes of the pans. They revealed that heavy density liquors up to 60° Brix were being entrained at practically every stage of the rich purity strikes. In one case the sampler even collected a large amount of well-formed crystals mixed with the entrained syrup.

Undetermined losses, therefore, can take place by entrainment in the evaporator and pans; by the loss of juice in the filtration of soft cakes; by leaks in heaters and pipings; by spillage; by decomposition by heat and inversion; and by the repeated circulation of molasses and jelly boilings. Undetermined losses are seldom less than 0·5 per cent. of the sugar in the juice, and may under unfavourable conditions rise to 4 per cent. It is desirable that the practice of reporting molasses and undetermined losses as one combined item should be discontinued, and with this object in view it is essential that no factory should be without a molasses scale.

Inversion of Sucrose by various Organic Acids. FIZIRO HAMAGUTI, TOSIHIDE SIMIZU and TOKUHIRO NIINUMA. *J. Soc. Trop. Agr., Taihoku Imp. Univ.*, **11,** pp. 300-308; through *Chem. Abs.*, 1940, **34,** p. 7131 — Hydrolytic power for 60 per cent. sucrose solutions at 50° decreased in the order, oxalic acid > maleic acid > malonic acid > citric acid > tartaric acid > formic acid > fumaric acid > malic acid > acetic acid.

Composition of Sugar Cane. KOITIRO HONDA, TUNEO TATUNO, Y. NAKAMURA, T. GODA, Y. MIMA and KAZUO YAMAHUZI. *Bull. Agr. Chem. Soc. Japan*, **16,** pp. 49-54; through *Chem. Abs.*, 1940, **34,** p. 7132.— Bagasse contained 44·66 per cent. of fibrous cells 1·051 to 1·172 mm. long and 0·018 mm. wide. After the removal of sugar the stem of cane contained ash 1·39 to 1·64, extraction with cold water 1·94 to 2·54, hot water 3·86 to 4·57, dil.-alk. 33·90 to 38·80, alc.-benzene 2·69 to 2·83, pentosan content 26·19 to 27·53, lignin 18·63 to 21·81, nitrogen 0·33 to 0·35, cellulose 47·75 to 50·32, α-cellulose 34·72 to 37·23, β-cellulose 4·97 to 7·12, and γ-cellulose 5·79 to 8·22 per cent. in dry matter.

Properties of Colouring Substances of the Cane Sugar Factory Juices. T. YAMANE and I. KAMIHIGOSI. *J. Soc. Chem. Ind. Japan*, **43,** Suppl., p. 142; through *Chem. Abs.*, 1940, **34,** p. 7134.—Adsorption of caramel by growing sugar crystals is maximum at 7·0 *pH*. This colouring matter is definitely localized at one end of the *b*-axis of the crystals, which was also observed with Congo red, methyl water blue, and like dyes, negatively charged in aqueous solution, but not with positive ones like neutral red and acid ones like methyl orange. Agitation of the medium has no effect on these results.

Spontaneous Combustion of Sugars. R. KOPECKY. *Listy Cukrovar*, **58,** pp. 7-8; through *Chem. Abs.*, 1940, **34,** p. 7135.—Because spontaneous combustion in sugars is similar to that occurring in coal the author develops that view that oxygen condenses on the surface of a sugar crystal and then becomes concentrated continuously. When the temperature of the mass of sugar reaches a critical level, the oxygen unites chemically with the sugar. The concentration occurred faster on larger surfaces than on smaller ones, on dry surfaces than on wet ones. For avoiding spontaneous combustion the author recommends protection from external radiation, cooling, small piles, thin layers, ventilation, non-catalytic walls and temperature measurements in sugar masses.

Physical Properties that control the Packing of Sugar. K. SANDERA. *Listy Cukrovar*, **58,** pp. 93-94; through *Chem. Abs.*, 1940, **34,** p. 7135.—For grains passing screens whose openings measured 0·3, 0·4, 0·6, 0·8 and 1·17 mm., using measurements made under a microscope, the author presents tables which give the average dimensions of grains, surface area, ratio of surface area to the weight, number of grains per grm. of sugar, weight of average grain, and ratio of the volume of crystals to the volume of the space between the crystals. These measurements agree with the observations made by PELLET.

Utilization of Bagasse. XIV. Drying. HARUZI KATO. *Cellulose Ind.* (Tokyo), **15,** pp. 475-478; through *Chem. Abs.*, 1940, **34,** 6473.—Drying by boiler flue gases is discussed.

Abstracts of the International Society of Sugar Cane Technologists.

Under the scheme initiated by the International Society, a collection of abstracts of papers on agricultural and technical subjects is prepared monthly. A selection from these "Sugar Abstracts" has been made by us from the material last issued, and is printed below.

CANE AGRICULTURE.

Economic Field Yields of Cane. W. H. SCHAUM. *Proceedings* 13*th Ann. Conf. Asoc. Tecnicos Azucareros Cuba*, 1939, pp. 289-293.

After a field has been planted it may continue to produce satisfactorily for a number of years, but each year the yield of the ratoon crops diminishes on account of various factors. The question arises: When should an old field be considered to have reached the limit of its economic life and be re-planted? The author reaches the general conclusion that under prevailing conditions re-planting should be done when the yield has fallen below 50,000 arrobas per caballeria (approx. 17 metric tons per acre).

Cane Varieties and their Influence on Sugar Yields. F. AGETE Y PINERO. *Proceedings* 13*th Conf. Asoc. Tecnicos Azucareros Cuba*, 1939, pp. 285-288.

A book is to be published by the Cuban Department of Agriculture with the object of presenting data on the average yields from the mills beginning with the 1920 crop, the percentages of the area occupied by the different cane varieties and the yields of these varieties being given by provinces. It will be seen that there has been an increase in the rate of planting new varieties, and there have been higher sugar yields. It is not very likely that this increase of sugar yield is due solely to fabrication improvements or to a riper cane being ground; here is justification for the view that it has been due chiefly to the new cane varieties, mostly to POJ 2878, which now occupies the highest percentage of the total cane-growing land.

Forms of Nitrogen for Cane. R. J. BORDEN. *Hawaiian Planters' Record*, 1940, **44**, No. 2, pp. 81-88.

Field experiments have generally failed to indicate a superior efficiency for any one form of nitrogen over another upon the production of cane or upon its quality. Pot experiments were therefore instituted to obtain some insight into particularly possible effects on cane quality; that is, tons of cane to make a ton of sugar.

Half of the pots with each soil were adequately fertilized with superphosphate; the other half received no phosphate. Nitrogen and potash, in adequate amounts for the type of culture proposed, were supplied similarly, except for the three forms of nitrogen which were being compared, i.e., ammoniacal nitrogen from ammonium sulphate, nitrate nitrogen from nitrate of soda, and synthetic non-proteid organic nitrogen from urea. Three kinds of soil were used.

There was some indication that urea gives a slightly better cane quality than ammonia as nitrate, but the results are so affected by other conditions that the drawing of definite conclusions is hazardous.

Amazon Fly as a Parasite of the Cane Borer. L. C. SCARRAMUZZA. *Proceedings* 13*th Ann. Conf. Asoc. Tecnicos Azucareros Cuba*, 1939, pp. 295-298.

The Amazon fly (*Metagonistylum minense*) has been ntroduced with great success into British Guiana and Trinidad as parasite of the cane borer. More recently a variant of this species was discovered in the State of Sao Paulo, Brazil, being distinguished by its adaptation to a region where the annual precipitation is only about 50 inches and winter temperatures near the freezing point.

A first introduction of this borer parasite into Cuba appears to have been successful. It is highly host-selective and has been found attacking only two species of the genus Diatraea, one the common *D. saccharalis* and the other an unidentified species in Trinidad.

Treating Seed Cane to hasten Germination. K. H. BERG. *Hawaii Farm and Home*, 1939, **2**, No. 12, p. 8.

Satisfactory germination of cane seed has always presented a problem on Hawaiian plantations. This has been especially true with body seed during the cold rainy months of the year on those plantations which suffer an unusual amount of cloudy, wet weather.

A few years ago a new product "Ceresan" was tried by the H.S.P.A. experiment station on the Kilauea Sugar Company, and was found to aid germination considerably, particularly in the cold wet lands of the Kailua sub-station.

In 1938 Lihue plantation planted a field of 32-8560 cane, partly with Ceresan-treated seed and partly with untreated seed. The difference between the two types of seed was so striking that the dipping of all seed in Ceresan solution was continued as a standard practice. This year most of the Hawaiian plantations treated their planting material with Ceresan.

Badila benefits only slightly from Ceresan, but varieties with longer internodes, such as 31-2806, respond very markedly. Similarly, the best responses

have been obtained with body seed. Where Ceresan has failed to stimulate germination, the reason may often be traced to the fact that top seed was planted.

Environmental conditions also affect germination Thus, Makaweli with good deep soils and favourable climatic conditions has not found it necessary to use Ceresan, but Kekaha, which enjoys equally favourable weather, reports that Ceresan is highly beneficial for germination on their saline flats. In an area with an extremely high salt content, 90 per cent. of the eyes of seed that had been dipped in 1 per cent. Ceresan solution and lime germinated. Previously it had been impossible to secure a satisfactory stand with untreated seed.

BEET TECHNOLOGY.

Control of Low-Grade Beet Sugar Massecuites in the Crystallizers. H. CLAASSEN. *Centr. Zuckerind.*, 1940, **48**, pp. 149-151, 165.

At no other point in the sugar factory is it more necessary to exercise a rational control than in the crystallization of low-grade massecuites, for it is here that the relative yields of sugar and final molasses are decided. It is here that many if not most German sugar factories are losing money, or at least failing to make it.

According to a survey by the Berlin Sugar Institute final molasses has an average purity of 64·2. It is well within the range of possibility to reduce the purity figure to 61 (and even lower). This would mean an increase of 6·6 per cent. in the output of crystal sugar on the molasses yield, or 0·25 per cent. on the weight of beets, and the molasses yield would be 0·35 per cent. lower.

For practical purposes it is essential to know the point at which the solubility of sugar in a factory syrup reaches a final limit; that is, the point where no more sugar will crystallize out of a molasses at a given temperature. The solubility of sugar in molasses has been determined by numerous authors, and tables, such as those of HOEGLUND and of GRUT, are available from which solubility figures may be read off.

But these tables represent only average figures. The fact is that the solubility of sugar in a beet molasses varies with the nature of the molasses, although it may be more or less constant for beets produced in a certain district in a certain year and worked up in a certain factory. The sugar technologist who wishes to obtain a completely exhausted molasses must know the solubility of sugar in his molasses.

The necessary procedure consists of taking half a dozen samples of molasses in bottles, adding to them graded amounts of crystal sugar, keeping these bottles in a water-bath at a given temperature for several days, weighing the sugar recovered from each bottle, and figuring the solubility from that bottle which yielded the most sugar per 100 parts of water, and a molasses of the least purity.

This solubility figure should be determined at the beginning of the campaign, and again when any material change has been made in factory conditions. It remains to use it for controlling the work at the crystallizers. This control consists essentially in figuring the amount of water to be added in the coolers, and in following the progress of crystallization with refractometric tests, which will indicate when the limit of crystallization has been reached.

Determination of Sucrose in Mother-Syrups. H. CLAASSEN. *Centr. Zuckerind.*, 1940, **48**, No. 35, pp. 581-584.

Since no decision as to which of the several methods of determining sucrose is the most nearly correct can be reached by analytical procedure, recourse must be had to a synthetical procedure. A way must be found to obtain all the non-sugars of molasses separate and free from sucrose; then if a known quantity of sucrose is added to this solution of non-sugars, a synthetic molasses of known sucrose content will be obtained and may be analysed by each of the four common methods.

A sample of waste molasses from a factory (Dessau) where molasses is de-sugared by the strontia process was obtained; after making a complete analysis of the slop it was compounded with enough sucrose to reconstitute the original molasses, and the four methods were applied with results as in the accompanying table :—

	Sucrose.	Purity.	Solubility.	Saturation at 45°C.
True sugar content	50·00	59·53	3·12	1·25
Direct polarization	51·77	61·63	3·24	1·29
Double polarization, using Clerget formula........	49·65	59·10	3·11	1·24
Do. using raffinose formula	48·55	57·70	3·04	1·22
Calculated from reducing sugars, before and after inversion..............	53·10	63·20	3·32	1·33
Double polarization, using the enzyme invertase ..	52·00	61·90	3·25	1·30

From these results it is seen that the true sugar content of the original molasses is most closely given by double polarization according to Clerget; the agreement is nearly exact.

The highest result is given by calculating the sucrose content from the reducing power of the inverted molasses; this method includes the products of overheating sucrose. This also explains the too high results of the enzymatic method, in which it is highly probable that some heat-decomposition products of sucrose are also inverted and calculated as sucrose. However, this point requires further study.

This work is a reconfirmation of the opinion expressed by HERZFELD in 1892 that the solubility number of sugar in impure mother-syrups is most accurately determined by calculation from the Clerget formula.

Brevities.

BRAZIL'S 1940-41 SUGAR CROP.—According to Lamborn, the current sugar crop in Brazil is forecast at 1,273,000 long tons, as compared with 1,175,000 tons in 1939-40, an increase of 8·3 per cent. This should set a new high record for production in that country. Consumption for the year ending August 31st, 1940, amounted to 1,067,000 long tons, so there should be a surplus available for export if markets can be found. In 1939-40 some 61,000 tons was shipped out of the country.

JAPANESE 1940-41 CROP ESTIMATES.—Production of sugar in Japan, including Formosa, for the current 1940-41 season is forecast (according to Lamborn) at 1,176,000 long tons, raw sugar value, as compared with 1,321,000 tons manufactured last season. This is a decrease of 145,000 tons or approximately 10·9 per cent. This figure if eventuated will make the crop the smallest for six years. Cane sugar is expected to yield 1,141,000 tons and beet sugar 35,000 tons. But according to later reports the crop has since suffered typhoon damage and the second estimate is some 7½ per cent. lower.

U.S.A. SUGAR BEET ACREAGE FOR 1941.—The Sugar Division of the A.A.A. at Washington has fixed the sugar beet acreage for 1941 on which conditional payments will be made to producers at 820,000 acres. This area compares with an approximate acreage of 990,000 planted in each of the three previous years and with an average of 833,000 in the previous ten-year period. This official reduction, the first to be made since the sugar programmes commenced in 1934, is due to the fact that the increasing production in the continental beet area during the past three years has resulted in the accumulation of excessive stocks of sugar, and the Sugar Act of 1937 requires that a balance be maintained between an area's sugar production and its marketing quota and carryover. This curtailment of beet sugar expansion will relieve some of the anxiety necessarily felt by cane sugar interests supplying the U.S.A.

ROOK *vs.* FAIRRIE LIBEL CASE.—Mr. J. Leslie Fairrie, the sugar broker, lodged an appeal against the judgment given by Mr. Justice Atkinson last September,[1] awarding £550 damages for libel to Mr. W. J. Rook, Director of Sugar Purchases at the Ministry of Food; and the case was heard in the Court of Appeal at the beginning of February. The defendant appealed on the ground that the Judge was wrong in holding that he had been guilty of malice. There was also a cross-appeal by the plaintiff on the ground that the damages awarded were insufficient. Counsel for plaintiff submitted that the damages given were wholly inadequate, bearing in mind Mr. Rook's high reputation all over the sugar world. The Judge, he suggested, was mistaken in thinking that his judgment, pronounced in London, would be read, understood and appreciated in all the circles that Mr. Rook felt his vindication should reach. The Court of Appeal after a hearing dismissed both appeals, and confirmed the Judgment of the Court below. The Master of the Rolls in giving judgment said that the libels in question consisted of a scurrilous and unfounded attack on Mr. Rook's integrity, and it seemed as clear as anything could be that the defendant throughout was actuated by the grossest form of malice. With regard to the cross-appeal, the Court would not interfere with the decision of Mr. Justice Atkinson on the question of damages, as the view which he took was supported by authority. In the course of the proceedings it was stated that the taxed costs of the case in September, which lasted 15 days, were as much as £2,200.

PHILIPPINES 1939-40 EXPORTS.—According to Warner, Barnes & Co. Ltd., the exports of sugar from the Philippine Islands to the United States for the campaign year 1939-40 (November-October) amounted to 858,651 long tons, of which 810,356 tons was centrifugals and 48,295 tons refined. The total in the previous season was 852,618 tons, of which 49,584 tons were refined.

SUGAR REFINED FROM GUR IN INDIA, 1940.—According to a memo. issued by Mr. R. C. Srivastava, the estimate of the quantity of sugar refined from gur in India during 1940 stands at 31,700 tons, as contrasted with 14,200 tons in 1939. The recovery of sugar is put at 57·53. This more than doubling of the 1939 production is due chiefly to a larger output in the U.P. where some 15,000 tons more was turned out. The number of factories engaged on this process is twelve.

INDIAN CROP FORECASTS, 1940-41 SEASON.—The first official forecast issued in India, covering the current 1940-41 sugar cane crop, was published in August last and estimated the total area planted to cane as 4,215,000 acres, as against 3,731,000 in 1939-40, an increase of 14 per cent. The second forecast, issued at the end of October, increased the estimated area to 4,244,000 acres. Weather conditions were stated not to have been quite favourable, but prospects for the crop were reported to be good on the whole.

INDIA AND THE INTERNATIONAL SUGAR AGREEMENT.—Delayed news to hand from India states that in October the Government announced to the Press that, according to information received from London, the application made by the Government of India for partial release from their obligations under the International Sugar Agreement, so as to enable India to export to the United Kingdom up to 200,000 tons of sugar during the calendar year 1940, had been granted. The Indian industry was thereupon open to negotiate the export to the U.K. of this or any less quantity.

POTASH FROM SEA-WATER.—A patent has been taken out by the Norsk Hydro Elektrisk Kvaelstof A.S. for the precipitation of potash from the bitterns produced in the evaporation of sea-water for the production of common salt. One of the salts of dipicrylamine (hexanitrodiphenylamine), generally the calcium, is added to the slightly alkaline solution to form an insoluble compound with the potash, this being filtered off, washed, and treated with an acid, preferably nitric, thus giving potassium nitrate and precipitating the dipicrylamine, which is recovered or re-used. An experimental plant has been erected at the Heroya works of the Company.

DEXTROSE IN CANDY.—"Approximately 500,000 tons of refined (cane) sugar in U.S.A., are used annually in the manufacture of candies, chocolates and cocoa. The amount of corn sugar (dextrose) used in the manufacture of these same products was (in 1937) about 10,000 tons. This when compared to refined sugar consumption is small. But there is a possibility that the use of corn sugar can be increased tremendously through the use of modern merchandising and promotional advertising and publicity methods (candy made from dextrose being claimed to be non-fattening). Millions of people are watching their weights, and the dextrose idea is appealing. Cane and beet sugar producers may find their big candy market decreasing to an alarming degree."[2]

[1] See *I.S.J.*, 1940, pp. 365 and 381-382.

[2] From an article on "Using Dextrose in Candy" in *The Sugar Journal* (Louisiana), 1940, 3, No. 6, p. 7.

Sugar-House Practice.

Tests with the Dorr Clarifier (in Queensland). G. H. Jenkins.[1] *Technical Communication No. 7 of 1940, Bureau of Sugar Experiment Stations, Brisbane.*

Tests have been carried out with the new "Multifeed" Dorr Clarifier, which was installed at Bingera Mill, Queensland, in 1939. It is 22 ft. in diameter and has four trays. Its main points of difference from the standard type of Dorr are the provision : (1) in the centre well of separate divisions for mud and juice ; and (2) of the large capacity "flocculating cell" into which the juice first enters.

Provision (1) is designed to ensure that the mud separated in any tray does not come into contact with the juice entering the next tray below, with consequent risk of re-dispersion of mud, and the possible adverse effect of settling in the lower trays. Provision (2), with its rotating panel, permits completion of the chemical and physical changes involved in the clarification process before the juice enters the clarifier proper. Each of the upper three compartments of the Dorr are 2 ft. in depth, while the bottom one has a depth of 5 ft. to allow time for thickening of the mud.

Objects of the tests were mainly first to investigate the clarity of the juice obtained in relation to the rate of flow; and secondly to determine the consistency of the mud delivered. At the same time the performance of the Dorr was compared with that of a conical subsider of the Queensland type having modern volute baffles and well-proportioned juice passages. Identical juice was, of course, used in both series of tests.

It was found that with practically the same rate of flow per tray in all cases the suspended matter in the clarified juice was definitely less for each tray of the Dorr than for the conical subsider, the average figures being 0·007 and 0·011 grm. per ml. for the two types of clarifying apparatus respectively. It was therefore concluded that, under comparable conditions, the Dorr gives a juice of superior clarity to that from a good conical subsider.

In regard to the nature of the mud, however, that from the subsider was considerably thicker than that from the Dorr. A composite sample taken during the withdrawal of the mud from the subsider gave a figure of 9·2 per cent. of suspended matter ; by way of confirmation of this result a snap sample was tested and found to show 8·8 per cent., which is considerably higher than for the mud of the Dorr in any of the tests. It is, therefore, concluded that the thickening of the mud in the Dorr was inferior to that in the conical subsider under the particular conditions of the tests.

Comparing the dimensions of the Dorr and the conical subsider, the latter has a depth of 13·5 ft. compared with 5 ft. for the mud compartment of the former apparatus. It follows that the time available in the thickening zone would be correspondingly greater in the conical subsider, and that a thicker mud should result. Further, the scrapers of the conical unit, extending as they do to a considerable height, might have an appreciable thickening action.

It appears, therefore, that to obtain a heavier mud a deeper bottom compartment on the Dorr Clarifier would be advantageous. Alternatively, or in addition, a thickening arrangement of the picket fence type extending about half-way up the bottom compartment would probably assist in improving the consistency of the mud discharged. It is pointed out that the above conclusions apply more particularly to districts as in the south of Queensland, where it is found difficult to obtain a thick mud. In the north of that country, for example, a heavy mud is readily obtained, and special provisions for thickening are less important.

Rates of flow per unit per settling area were much lower than in previous tests at a Northern mill, indicating the greater settling area required per ton of cane per hour with the slow settling muds encountered in the Southern districts of Queensland. It is also remarked that the "flocculating cell" on top of the Dorr Clarifier appears to perform a useful function as a buffer tank as well as permitting complete precipitation before the juice enters the settling chambers of the clarifier.

Manufacture of Invert Molasses (using Invertase). Wm. L. Owen. *Facts about Sugar*, 1940, 35, No. 6, pp. 37-38.

In view of the fact that the production of invert molasses gives promise of becoming a permanent industry in Cuba, and perhaps also in Puerto Rico, efforts are being made to improve the somewhat crude methods now in use.[2] Such methods consist in the main in the inversion of the sucrose by strong acids (e.g., sulphuric), followed by neutralization with soda ash, and evaporation of the invert syrup to a density around 95 to 90° Brix.

Disadvantages of such methods outweigh the advantages of their simplicity. In the first place, the amount of salts produced from the neutralization of the acid used detracts from the value of the product from most of the purposes for which it is used, and especially if for cattle feed purposes. Secondly, there are considerable losses of sugar, about 4 per cent. of the total sugars in the molasses. Thirdly, there is the matter of the deterioration of the plant by the use of such strong acids at high temperatures.

1 Assistant Mill Technologist of the Bureau.

2 *I.S.J.*, 1938, p. 242.

In the last few years, however, some of the larger producers of invert molasses in Cuba have adopted the use of yeast invertase as an inverting agent,[1] and the results are said to be very satisfactory. But the method of applying yeast invertase appears to fall short of what it might be if the process of first autolysing the yeast as described by the author were applied. It is economical and efficient, and consists of the following steps :

(1) Molasses or juice is diluted to about 4° Brix and this mash fed into yeast generators, equipped with spargers through which a very large volume of low pressure air is supplied. (2) The yeast cells are separated from the mash by passing it through centrifugal machines. (3) The concentrated yeast thus separated is autolysed or self-digested in special tanks equipped with hot water coils to maintain a suitable temperature. (4) Lastly, this autolysate (which contains invertase in a concentrated form) is transferred to special stowage tanks, from whence it can be drawn for use as required.

This is a great improvement on the present method of inverting with yeast as being practised in Cuba, in which the yeast without being autolysed is directly added to the syrup or molasses maintained at a temperature too high to permit of fermentation, but high enough to permit of the inverting action of the enzyme invertase present in it (about 50°C.). Its main defect resides in the fact that the yeast is not autolysed properly, so that a much lower inverting power is obtained per unit weight of yeast used than if the cell liquefaction had been made complete.

As a result of the incomplete liberation of the invertase from the yeast cells in such a process, much more cellular material is included with the invertase, and more foreign matter is added to the molasses to be inverted than would otherwise be the case. Another point is that the invert molasses produced in this way would be very susceptible to spontaneous decomposition, owing to the reaction between its reducing sugars and the amino-acids thus added. On the other hand, the invert molasses made by means of fully autolysed yeast would be free from such defects. It is likely that the product so produced would soon come to demand a premium from distillers and from cattle feed manufacturers.

Boiler Scale Removal by Molasses Fermentation. F. C. Williams. *Proceedings of the 14th Congress of the South African Sugar Technologists' Association*, 1940, p. 145.

This method of cleaning boiler or evaporator tubes has been employed by the author for the past nine years. He fills the boiler to a point well above the water line with a solution of molasses at 10° Bé, the temperature of which is not allowed to fall below 70°C.

Fermentation sets in spontaneously with the free evolution of hydrogen, an indication of the formation of which is the appearance of bubbles on the surface of the wash. It is hardly necessary to remark that naked lights should not be allowed near the manhole of the boiler at this stage.

After nine or ten days the surface of the plate should be examined to see if the scale has started to soften. It probably has, but it will be necessary to wait for two to three weeks before the scale has become quite soft. When this has happened, the wash should be lowered a couple of inches below the water-line ; and if, on wiping it, the plate is found to be quite clean, the boiler should be emptied.

Following this, the boiler should be filled completely with water, and sufficient paraffin added, so that when it is slowly emptied a film of the oil is left on the boiler-plate. A quantity of scale in the form of sludge will be found at the bottom of the boiler, and this is easily washed out by means of a hose pipe. In the case of B. & W. boilers, the tubes are brushed well.

It is important that the boiler should be emptied as soon as the plates are clean, otherwise there is a possibility of pitting setting in. This method of scale removal can be applied in the same way to the cleaning of evaporators.[2] It is reported that distilleries in Germany are applying the method with success, their practice being to add about 1 lb. of molasses per sq. ft. of heating surface.

Fuel and Steam Balance of a Sugar Factory. J. R. Nicholson.[3] *Proc. Queensland Soc. Sugar Cane Tech. 11th Conf.*, 1940, pp. 257-262.—Not all the sugar mills in Queensland find it possible with their wide range of fibre to reach a fuel balance on bagasse alone. By changes in plant considerable savings can be made, but the costs must be carefully watched. It is at the effects that the greatest gain is usually possible, and three separate steam balances were calculated by the writer in order better to study the position, namely : (1) with four vessels, bleeding from the 1st for primary juice heating, and using exhaust steam for secondary juice heating ; (2) with five vessels and the same juice heating arrangements ; and (3) with five vessels and bleeding from the 2nd to primary juice heating and using exhaust steam for secondary juice heating. Each balance assumed 216,000 lbs. of juice of 16·52° Brix entering the effects and 51,000 lbs. of syrup of 70° Brix leaving, the form of balance drawn up being a modification of that used by Webre and Robinson in their book,[4] and the steam consumption per hour for the three systems including juice heating being : (1) 58,150, (2) 52,370, and (3) 49,040 lbs. Hence the advantage of (3) over (1) is 9,110 lbs. Assuming

1 That is, the so-called Guerrero process ; *I.S.J.*, 1940, p. 259.
2 *I.S.J.*, 1937, p. 484.
3 Kalamia Estate, Ayr, Queensland.
4 "Evaporation."

the capital cost of making the change to be £7,000, the total annual charges (interest, sinking fund and maintenance) would amount to £708, and the annual savings to £2,850. Other advantages resulting from the change from quadruple to quintuple evaporation are that the condenser load would be reduced (by 18 per cent. in an example) with a corresponding reduction in the quantity of injection water needed for the effects, more condensates for mill purposes, less vapour going to the condenser, and a reduced tendency to entrainment.

A New Mill Principle which reduces Sugar Production Cost. E. W. KOPKE. *Facts about Sugar*, 1940, **35**, No. 12, pp. 30-32.—"Possibilities of far better milling performance with less equipment have been abundantly demonstrated by the old type of mill, which reaches excellent extractions occasionally when a certain combination of conditions prevails. These essential conditions, however, cannot be controlled or maintained in mills of the conventional type. The chief reason is that a single floating roll in a 3-roll mill, no matter how mounted or favoured so as to facilitate its movement, cannot possibly apply consistent or uniformly effective treatment to two separate pressure lines or zones. Since the conditions vary widely and continuously at these zones or pressure lines, dependable results can be obtained only by applying entirely independent action and freedom of responsiveness on the feed and discharge rolls of the mill. This, then, establishes in effect two separate and distinct milling units within the single assembly, each functioning independently of the other, though automatically inter-related." Details are not disclosed, but primary essentials in the "dual pressure" mill are explained to be as follows: (1) Independently pressured and free floating feed roll. Integral mounting of feed (cane) roll with turnbeam. Movement of feed roll and turnbeam, turnplate assembly to maintain alignment, longitudinally, with top roll flanges. (2) Independently pressured, free floating discharge roll. Non-resistant responsiveness to roll misalignment, thereby ensuring full contact of bearing with journal, and also free alignment with top roll flanges. (3) Elimination of space variations between top roll and turnplate or reduction of same to a minimum. (4) Rams of sufficient length to ensure freedom from pinching or restraining side pressures.

Distributing Gutter for Imbibition Juice. J. W. MUNTER. *Archief Suikerind. Nederl.-Indië*, 1940, **1**, p. 122.—When imbibition juice with its fine bagasse is returned to one of the previous mills (using e.g. the Wallwin pump), the type of distributing gutter generally employed is not very satisfactory. It does not allow of an even discharge over the whole breadth of the carrier owing to obstruction by coarse pieces of bagasse. This can be overcome by the use of a design of distributing gutter, which has already proven itself practicable in Java. It consists of an equalizing gutter, the contents of which overflows into the distributing gutter proper, and from thence over to the mill roller. But along the breadth of the distributing gutter there are revolving blades which evenly push the bagasse over the edge, the rate of revolution of its blades being about twice that of the top rollers.

Volumetric Meter Research by the A.S.M.E. EDGAR E. AMBROSIUS and HOWARD S. BEAN.[1] *Mechanical Engineering*, 1940, **62**, pp. 677-681.—This is an interim report of the American Society of Mechanical Engineers' Committee on Fluid Meters, which describes the programme they have in view, namely the testing at the University of Oklahoma of a group of representative meters for use in 2 in. and 4 in. lines, while varying the rate of flow from 5 to 125 per cent. with a possible maximum rate of about 450 U.S. galls. per min. Meters to be tested are classified into: (1) weighing, (2) volumetric, and (3) velocity; to the first belongs the tilting trap type; to the second, nutating disc, reciprocating piston, planetary piston, sliding or rotating vanes, and gear or lobed impeller types; and to the third, helical and turbine meters. These types are here illustrated.

Simple Way of Controlling the Work of the Centrifugal Process. J. VAN GEENEP. *Archief Suikerind. Nederl.-Indië*, 1940, **1**, No.3, pp.76-78. Encouragement should be given to the foreman-in-charge of the centrifugals to observe the quality of the sugar passing before him. In order to give effect to this idea, the end of the trough transporting the sugar to the mixer is so tapped with a tube of small bore as to cause it to drop crystals continuously into a small glass cylinder placed beneath it. Matters should so be adjusted that it takes about an hour to fill each cylinder, all those collected during the shift being collected in a row to facilitate easy inspection of the samples, in particular of their colour.

New Tube Cleaner for Evaporator Tubes. MORRIL B. SPAULDING. *Proc. 13th Conf. Assoc. Sugar Tech. Cuba*, pp. 87-91.—Instead of brushes, a "bladed head" is used for the removal of the scale, this element consisting of a cylinder in which are placed radially three or more metal blades, having a bevelled edge placed towards the direction of rotation. These blades are thrown out by centrifugal force when the element is revolved, a rotary motor actuated by compressed air at 85 lbs. per sq. in. being used. It is said that no vibration is caused in the tube being cleaned, nor is excessive pressure exerted against its walls, the final result being to burnish the metal and produce a surface on which scale does not easily form. Its capacity is stated as 50 tubes per hour.

[1] Senior Physicist, National Bureau of Standards, Washington.

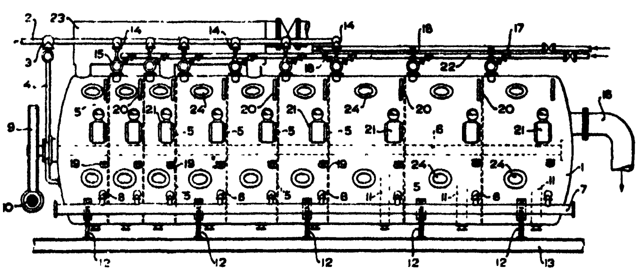
Review of Recent Patents.

Copies of specifications of patents with their drawings can be obtained on application to the following—*United Kingdom:* Patent Office, Sales Branch, 25, Southampton Buildings, Chancery Lane, London, W.C.2 (price 1s. each). Abstracts of United Kingdom patents marked in our Review with a star (*) are reproduced with the permission of the Controller of H.M. Stationery Office, London from the Group Abridgements issued by this Department. Sometimes only the drawings are so reproduced. *United States:* Commissioner of Patents, Washington, D.C. (price 10 cents each) *France:* L'Imprimerie Nationale, 87, rue Vieille, du Temple, Paris *Germany:* Patentamt, Berlin, Germany.

UNITED KINGDOM.

Continuous Crystallization Process and Apparatus. WERKSPOOR N.V., of Amsterdam, Holland. 527,992. April 25th, 1939; convention date, May 9th, 1938.

In a process for continuously crystallizing sugar and like solutions, the solution is passed through a boiling apparatus divided into separate chambers, the ratio of the weight of the crystals to the quantity



of the mother-liquor and the degree of the supersaturation of the latter being individually regulated in each chamber by supplying heat and by drawing in syrup.

The boiling apparatus used is provided between its inlet and outlet ends with means for compelling the mass to flow through so that crystals and mother-liquor move uniformly from one chamber to the next. Such means may comprise, e.g., a set of discs arranged as in the manner described in U.K. Patent No. 378,341 with their passages in staggered relation, so as to prevent a direct flow from the inlet to the outlet end of the apparatus. Heating elements are to be arranged in the first chambers of the series in such a manner that they can influence only one and the same stage of the boiling process.

It is thus possible to generate crystals in the first chamber of the crystallizing apparatus. It is, however, necessary to interrupt the formation as soon as the desired number is obtained, using ample additions of diluted sugar solution or of water to do so. Then the mass under treatment is passed, without any addition of sugar solution, through the next succeeding chamber, where the supersaturation required for the growth of the crystals is again established. In the following chambers where the crystals grow further, sugar solution is added to the mass. After this period for the growth of the crystals, the final boiling stage follows during which no further solution is added. When in the boiling apparatus crystals are not generated but "seed" crystals are added, the unsaturated solution should be concentrated in the first chamber to a slight degree of supersaturation, and in the following chamber powdered sugar is introduced without adding sugar solution to the mass in this chamber. In the following chambers the crystals then grow under the addition of sugar solution.

In order to exhaust the mother-liquor as far as possible, the molasses proper, i.e., that obtained by centrifuging the continuously boiled massecuite, may be re-introduced during the boiling process. Control of the crystallization is very important. To this end each main chamber is provided not only with a proof-stick or proof-cock and a thermometer, but also with a conductivity apparatus for determining the supersaturation of the mother-liquor.

Apparatus for use in this process is shown in the drawing, in which 2 and 4 are conduits for supplying the saturated solution, 5 are partitions dividing the vessel 1 into chambers, 6 is the rotating shaft, 11 the heating elements, and 9 a worm wheel. It is not necessary that all the chambers are contained in one and the same vessel, if space available is more suitable for arranging two short vessels than for one long one.

Process of Manufacturing Sugar. GUILLAUME LAMBINON, of Brussels. 523,268. December 29th, 1938.—Juice is heated to 110°C. for the coagulation of its colloidal non-sugars, treated with a base for the neutralization of its natural acidity, and centrifuged, the juice thus clarified being then concentrated, after which the syrup is boiled and treated in the usual manner for the separation of its sugar content and the formation of final molasses.

HOLLAND.

Method of Decolorizing Sugar Juices (using Hydrogen Peroxide and Decolorizing Carbon). DEUTSCHE GOLD- UND SILBER SCHEIDEANSTALT, of Frankfurt a.-d.-Main, Germany. 47,704. February 15th, 1940.—Claim is made for the method of decolorizing sugar juices by treatment with hydrogen peroxide and decolorizing carbon (or other surface active substances, as silica gel) in the presence of one another, thereby obtaining a better effect than with either separately. In an example, a heavy syrup is treated with from 0·1 to 0·15 per cent. by weight of 30 per cent. H_2O_2 with the simultaneous addition of decolorizing carbon, being stirred for 15 minutes. A better effect is obtained with 0·5 per cent. of carbon plus 0·1 per cent. of 30 per cent. H_2O_2 than

would be obtained with 2 per cent. of the same carbon without H_2O_2. Again, if 0·5 per cent. of the carbon + 0·05 per cent. of 30 per cent. H_2O_2 be used, then the decolorizing effect is the same as if one were to use 2 per cent. of the carbon alone. Char filters are said to last two to three times longer when H_2O_2 is used in this way. (Reference is made to F. R. BACHLER'S U.S. Patent No. 1,131,308, using hydrogen peroxide absorbed in kieselguhr[1]).

UNITED STATES.

Beet Topper. CLAUDE W. WALZ. 2,208,823. July 23rd, 1940.—This invention relates to a sugar beet topper and digger, and its principal object is to remove the tops from the beets while they are still in the ground. It is designed to automatically regulate the knife as to depth of cut in accordance with the size of the root.

Synthetic Manure. MARTIN LEATHERMAN ; dedicated to the use of THE PEOPLE OF THE UNITED STATES OF AMERICA. 2,218,695. October 22nd, 1940.– Claim 1 : The process comprising treating plant residues with water solutions of inorganic nutrient salts containing an agent having the property of destroying the normal wate· repellent characteristic of plant residues without inhibiting fermentation, thence decomposing the material treated by fermentation.

Weighing Matter in a Liquid Vehicle (e.g., Diffusion Juice). ALBERT L. COOPER (HOLLY SUGAR CORP., of Colorado Springs, Colo.). 2,197,204. April 16th, 1940.—It is the function of the apparatus described in this specification to effect an accurate determination preferably in terms of weight of the material carried by and ultimately to be recovered from a liquid vehicle, and to accomplish such determination while such material is in combination with its liquid vehicle. It may be connected with the outlet header of a battery of diffusion tanks.

Refining Saccharine Liquids. WM. A. LA LANDE, JR. (assignor to the POROCEL CORPORATION, of Philadelphia). 2,211,727. August 13th, 1940.—Claim is made for the method of refining a saccharine liquid, which comprises bringing said liquid into intimate contact with bauxite which has been heated to a temperature within the range of from about 600 to about 900°F. for a period of time sufficient to reduce its volatile matter content to between about 2 to about 10 per cent. by weight, and thereafter cooled, thereby to remove impurities from said liquid, and thereafter separating the liquid from the bauxite.

Cane Car. KAARE O. ASPER (assignor to the PRESSED STEEL CAR CO., INC., of Pittsburgh, Pa., U.S.A.). 2,211,683. August 13th, 1940.—Claim is made in a car underframe structure including wooden end and longitudinal sills, a combination sill bracket and post structure comprising an inverted L-shaped base overlapping the outer face of the end sill and the top faces of the end sill and adjacent end of the longitudinal sill, apertured means defining the lower edge of the L-shaped base at the outer face of the end sill and terminating above the bottom face of the end sill, a base plate disposed beneath the said end and longitudinal sills and beneath said L-shaped base, and bolts connecting the said L-shaped base and base plate at said apertured means and at said longitudinal sill, the bolts at said longitudinal sill being disposed at opposite sides thereof.

Process for manufacturing Sugar (Clarification of the Juice by Carbonatation). ROY L. LAY (assignor to WALTER J. KELLOGG and I. W. REED, of Rocky Ford, Colo., U.S.A.). 2,214,281. September 10th, 1940.—Claim is made for a process for the manufacture of sugar having the following steps ; carbonatation of the juice, filtration of the juice from the sludge, pressing of the sludge to extract the juice remaining therein, washing of the pressed sludge cake, a second carbonatation of the juice from the filtration step, a pressing of the juice from the second carbonatation step ; the intermediate step of returning all of the waters from the washing step and all of the juice from the first pressing step to the first carbonatation ; thence passing them through the second carbonatation to further purify them before passing them to the second pressing step along with juices from the second carbonatation.

Activated Carbon and Process of making the same. GEORGE H. SCHEFFLER (assignor to the DARCO CORPORATION, of Wilmington, Del., U.S.A.). (*A*) 2,216,756 ; (*B*) 2,216,757. October 8th, 1940.—(*A*) Claim 1 : The process of preparing activated carbon which comprises heating a mixture of finely divided wood and phosphoric acid to a temperature of at least approximately 300°C. and not over approximately 350°C., cooling the hot mass, washing with water until the carbon is substantially free from phosphoric acid, and drying the washed carbon to a moisture content of substantially from 35 to 60 per cent. Claim 6 : A process of producing activated carbon from black liquor which comprises calcining a mixture of black liquor and an alkali metal hydroxide, in such proportions that the ratio of alkali metal hydroxide to organic solids in the black liquor is at least 2 to 1, to a temperature of from 500 to 600°C., cooling the resulting material, washing the carbon with water, and maintaining the water content of the carbon at at least 50 per cent. until time for use.

1 Reference should also be made to French Patent No. 775,471 ; *I.S.J.*, 1936, p. 361.

Sugar Crops of the World.

THE FOLLOWING ARE WILLETT & GRAY'S NEW CROP ESTIMATES.

	Harvesting Period.	1940-41. Tons.	1939-40. Tons.	1938-39. Tons.	1937-38. Tons.	1936-37. Tons.
United States—Louisiana	Oct.-Jan.	209,821	400,814	439,029	357,243	342,423
Florida	Dec.-April	105,715	63,117	81,753	50,789	47,515
Puerto Rico	Jan.-June	810,325	909,646	760,678	961,720	889,594
Hawaiian Islands	Jan.-Dec.	865,000	850,000	864,636	819,628	821,990
Virgin Islands	Jan.-June	7,500	6,461	5,300	3,503	7,570
Cuba	Dec.-June	2,300,000	2,816,462	2,758,552	3,017,718	3,012,968
British West Indies—Trinidad	Jan.-June	122,000	92,187	128,455	133,627	154,285
Barbados	Jan.-June	90,000	70,331	136,257	89,118	108,264
Jamaica	Jan.-June	148,040	99,321	117,946	118,318	106,601
Antigua	Feb.-July	22,000	14,001	22,517	22,225	33,025
St. Kitts	Feb.-Aug.	38,000	30,892	37,336	27,935	34,272
Other British West Indies	Jan.-June	11,000	8,374	8,682	10,339	13,115
French West Indies—Martinique	Jan.-July	55,000	59,506	68,404	54,565	49,756
Guadeloupe	Jan.-July	43,000	50,000	46,658	47,809	54,654
Dominican Republic	Jan.-June	375,000	454,812	431,705	418,804	446,615
Haiti	Dec.-June	30,000	39,746	40,665	40,178	36,007
Mexico	Dec.-June	295,000	291,999	326,753	298,508	278,124
Central America—Guatemala	Jan.-June	36,000	34,843	33,648	34,132	31,170
Salvador	Nov.-Mar.	15,000	14,000	13,925	16,244	17,078
Other Central America	Jan.-June	42,000	40,000	45,500	48,756	54,932
South America—Demerara	Oct.-June	190,000	156,000	189,245	196,502	186,875
Colombia	Oct.-June	42,000	45,000	44,912	47,201	39,546
Surinam	Oct.-Jan.	15,000	15,000	18,000	14,421	15,733
Venezuela	Oct.-June	27,558	24,605	25,589	22,637	20,538
Ecuador	June-Jan.	20,000	18,000	24,609	21,652	17,477
Peru	Jan.-Dec.	450,000	466,202	372,169	337,860	406,357
Argentine	June-Oct.	500,000	521,584	465,630	371,152	435,874
Brazil	June-May	1,272,405	1,154,111	1,080,831	984,865	883,730
Total in America		8,137,364	8,747,014	8,589,384	8,567,449	8,546,088
British India (Gur)	Dec.-May	3,100,000	3,180,972	2,890,476	3,778,964	4,536,960
(White)	Oct.-July	1,212,000	1,333,200	786,800	1,099,200	1,248,450
Java	May-Nov.	1,750,000	1,576,506	1,550,738	1,376,868	1,392,146
Japan	Nov.-June	1,176,530	1,321,447	1,663,750	1,203,018	1,192,690
Philippine Islands	Nov.-June	1,087,000	940,382	881,714	945,398	998,060
Total in Asia		8,325,530	8,352,507	7,773,478	8,403,448	9,368,306
Australia	June-Nov.	825,000	932,825	822,744	809,852	786,909
Fiji Islands	June-Nov.	120,000	114,312	134,578	140,773	148,267
Total Australia and Polynesia		945,000	1,047,137	957,322	950,625	935,176
Egypt	Jan.-June	167,000	155,000	162,053	160,211	137,908
Mauritius	Aug.-Jan.	326,000	229,460	321,310	313,816	300,340
Réunion	Aug.-Jan.	80,000	73,573	85,735	79,878	83,761
Natal	May-Jan.	510,000	531,746	466,725	452,874	398,578
Mozambique	May-Oct.	70,000	67,500	63,284	64,369	75,730
Total in Africa		1,153,000	1,057,279	1,099,107	1,071,148	996,317
Europe—Spain	Dec.-June	10,000	6,666	13,124	12,222	15,747
Total cane sugar crops		18,570,894	19,210,603	18,432,415	19,004,892	19,861,634
Europe—Beet sugar crops†		9,234,000	9,585,852	8,670,373	9,627,388	8,712,909
United States—Beet sugar crop††	July-Jan.	1,543,750	1,467,803	1,485,024	1,147,185	1,167,530
Canada—Beet sugar crop††	Oct.-Dec.	90,000	75,573	63,883	53,796	67,783
Total beet sugar crops		10,867,750	11,129,228	10,219,280	10,828,369	9,948,222
Grand Total—Cane and Beet Sugar	Tons	**29,438,644**	**30,339,831**	**28,651,695**	**29,833,261**	**29,809,856**
Estimated Decrease in world's production	Tons	901,187	*1,688,136	1,181,566	*23,405	*1,998,841

* Increase. †† Refined Sugar.

† European Beet Crop figures are furnished principally by F. O. Licht, see page 76.

Stock Exchange Quotations of Sugar Company Shares.

LONDON.

Company.	Quotation February 20th 1941	Quotation January 21st 1941	1941 Prices Highest.	1941 Prices Lowest
Anglo-Ceylon & General Estates Co. (Ord. Stock)	1 3/16 — 1 5/16 per £1 unit of Stock	1 3/16 — 1 5/16 per £1 unit of Stock	25/3	24/6
Antigua Sugar Factory Ltd. (£1 Shares)	3/8 — 5/8	3/8 — 5/8	8/9	8/9
Booker Bros., McConnell & Co. Ltd. (£1 Shares)	2 3/8 — 2 5/8	2 3/8 — 2 5/8	52/6	52/6
Caroni Ltd. (2/0 Ord. Shares)	1/0 — 1/6	1/0— 1/6		
(6% Cum. Pref. £1 Shares)	1 — 1 1/8	15/16 — 1 1/16	20/6	20/3
Gledhow-Chaka's Kraal Sugar Co. Ltd. (£1 Shares)	1 3/16 — 1 5/16	1 3/16 — 1 5/16	22/0	22/0
Hulett, Sir J. L. & Sons Ltd. (£1 Shares)	24/0 — 25/0	24/0 — 25/0	25/0	22/1 1/2
Incomati Estates Ltd. (£1 Shares)	3/16 — 5/16	3/16 — 5/16		
Leach's Argentine Estates Ltd. (10/0 units of Stock)	6/0 — 6/6	6/0 x.d. 6/6	6/6	6/3
Reynolds Bros. Ltd. (£1 Shares)	1 23/32 x.d. 1 27/32	1 13/16 — 1 15/16	38/0	32/7 1/2
St. Kitts (London) Sugar Factory Ltd. (£1 Shares)	1 5/8 — 1 7/8	1 5/8 — 1 7/8		
Ste. Madeleine Sugar Co. Ltd. (Ordinary Stock)	21/32 — 23/32 per £1 unit of stock.	5/8 — 11/16 per £1 unit of stock	13/0	11/9
Sena Sugar Estates Ltd. (10/0 Shares)	1/4 — 5/16	1/4 — 5/16	6/1 1/2	5/0
Tate & Lyle Ltd. (£1 Shares)	47/6 — 48/6	47/3 — 48/3	48/3	46/6
Trinidad Sugar Estates Ltd. (Ord 5/0 units of Stock)	5/0 — 6/0	5/0 — 6/0		
United Molasses Co. Ltd. (6/8d. units of Stock)	23/9 — 24/3	24/3 — 24/9	2 /1 1/2	23/3

NEW YORK (Common Shares).†

Name of Stock	Par Value	Closing Price Jan 10th, 1941	1940-41. Highest for the Year	1940-41. Lowest for the Year
American Crystal Sugar Co.	No par	10 5/8	15 1/4	8
American Sugar Refining Co.	$100	15 5/8	23 3/8	12 3/4
Central Aguirre Associates	No par	19	26 1/4	17
Cuban American Sugar Co.	$10	4 3/8	8 7/8	3 1/2
Great Western Sugar Co.	No par	21 1/2	29 1/8	18 3/8
South Puerto Rico Sugar Co.	No par	18 1/4	30 3/4	16

† Quotations are in American dollars and fractions thereof

United States, All Ports.

(Willett & Gray)

	1941 Long Tons.	1940 Long Tons.	1939 Long Tons.
Total Receipts, January 1st to January 11th	97,516	107,011	119,695
Meltings by Refiners ,, ,, ,,	88,374	97,043	113,994
Importers' Stock, January 11th	35,019	72,851	15,477
Refiners' Stock ,, ,,	240,818	373,686	190,206
Total Stock ,, ,,	275,837	446,537	205,683
	1940	1939	1938
Total Consumption for twelve months	5,712,587	5,648,513	5,604,051

Cuba.

(Willett & Gray)

	1941 Spanish Tons	1940 Spanish Tons.	1939 Spanish Tons
Carry-over from previous crops	1,181,390	588,293	729,172
Production to January 11th	—	—	—
	1,181,390	588,293	729,172
Exports since January 1st	59,864	69,582	68,618
Stock (entire Island) January 11th	1,121,526	518,711	660,554

The Market in New York.

No development of particular importance has presented itself in the domestic market during the past month, but a steady increase in the price level has been witnessed owing to a more consistent demand for raws on the part of refiners. This would appear to be partly due to the renewed tension in the Far East and the desire of buyers to build up stocks in case the situation becomes worse. Shipments from the Philippines are already subject to some interruption at present, owing to the shipment of defence materials being given priority and the resultant commandeering of space previously arranged for sugar. In these circumstances, neither buyers nor sellers are anxious to deal in Philippine sugars until they have been shipped and are nearing their destination. Shipping opportunities are also further reduced by the reluctance to charter Japanese vessels for this business. Nevertheless, Philippine sugars have participated to a large extent in the increased volume of trade over the past four weeks, but this is explained by the fact that exports from the Philippine Islands during November/December, 1940, were 185,972 tons against only 79,000 tons in 1939, and quite a large proportion of these shipments would arrive during February and early March. The total volume of business reported is approximately 175,000 tons, up to the parity of 2·10 cents, c. & f., New York, being paid for arrived and nearby sugars, 2·13 cents for March arrival and 2·15 cents for late March/April arrival. Sellers are showing less inclination to press and are asking 2·20 cents and parity for March/April arrival but buyers are not yet prepared to pay this price.

On two or three occasions a good demand for Refined was experienced but so far refiners have not announced any further increase in their quotations.

Quiet and featureless conditions prevailed in the domestic Futures market during the first half of the period under review with the general trend of prices unaffected by small daily fluctuations. The past two weeks, however, has seen a gradual marking up in quotations which at the close on the 21st were 8 to 9 points higher as compared with the 23rd January.

The chief feature of interest likely to affect prices in the No. 4 World Futures Contract is that an agreement was reached on the 22nd January between the Export & Import Bank, New York, and the Cuban Government for financing part of Cuba's quota for outside the United States. The agreement is subject to ratification by Cuban Congress, regarding which we have no news so far. Under the terms of the agreement, the bank will advance $4 per bag on 400,000 tons non-U.S. Cuban sugar to be produced during the 1941 crop and this sugar is to be stored in Cuban warehouses. The loan is to be for a period of eight years at an interest rate of 3 per cent. per annum and is to be amortized by the sale of 50,000 tons annually to non-U.S. markets, but if this is not possible, the 50,000 tons is to be included in the U.S. quota. A tax of 6 cents per bag is to be imposed on the entire Cuban production to cover carrying charges and interest. Once the loan is finally ratified, the Cuban production will be fixed between 2,300,000 and 2,400,000 tons. Grinding commenced on the 16th January.

It is not possible at this stage to assess the influence the loan prospects have had on the Futures market but it appears that a substantial position in March delivery has so far been liquidated rather more easily than might have been anticipated.

Scattered liquidation and some active switching from March to more forward positions resulted in nearby deliveries dropping to lower levels, but the ready absorption of 28,700 tons March tendered on the 17th February brought renewed covering and some new buying, and the market is now quietly steady. Compared with our last report, March to September deliveries are 5 points to half a point lower with December, and March, 1942, half a point and 2 points up respectively. May, 1942, is 6½ points higher than the opening quotation on 11th February.

C. CZARNIKOW, LTD.

21, Mincing Lane,
London, E.C.3.
February 24th, 1941.

GILCHRIST PATENTS.—Petree & Dorr Engineers, Inc. has acquired through its parent company, the Dorr Co. Inc., all rights for the sugar industry under a group of patents formerly owned by Gilchrist & Co. These rights cover the Gilchrist Clarifier with its bell-shaped trays, other clarifier and mixing apparatus, treatment processes, flocculation of sugar juices, and the Gilchrist furnace.

SEYMOUR HOWE BURSARIES.—The Queensland Society of Sugar Cane Technologists has decided to perpetuate the memory of the late W. F. Seymour Howe by creating two memorial bursaries to be awarded annually, and to be tenable at the Central Technical College, Brisbane. They will be awarded to suitable applicants who have completed the second year of the diploma course in sugar technology, or to students who have completed the third year of the course.

ATTEMPT TO PATENT NEW BACTERIA.—C. F. Arzberger (Commercial Solvents Corporation) isolated from soil a new species of bacteria fermenting sugar mashes to yield butanol, acetone and ethanol. He named it *Clostridium saccharo-butyl-acetonicum-liquefaciens*, and filed an application for its patenting in the U.S. under the provisions of the plant patent statute.[1] The Examiner rejected the claim on the ground that bacteria are not patentable subject matter. This was appealed against, but the final decision was that the plant provision of the U.S. patent law does not permit the patenting of bacteria, firstly because it is not certain that bacteria are actually plants, and secondly because the Court was of the opinion that Congress had not intended to extend such protection to bacteria. However, this patentee has not gone unrewarded as he has been granted U.S. Patent 2,139,108 covering the process of obtaining neutral solvents from sugar mashes through the agency of the above-named bacteria.

1 *Ind. & Eng. Chem.* (News Edition), 1940, 18, p. 852.

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Notes and Comments.

The War.

The record of the past month has continued, in the main, one of preparation for the generally expected Spring offensive. but actual fighting has been confined to the Greek-Italian front where the Greeks have smashed up weighty Italian counter-offensives, and to the African campaign where converging British forces are making headway in ridding Abyssinia of its Italian conquerors. But the Balkan thrust on the part of the Germans has not, at the time of writing, got beyond the war of nerves that is invariably the first stage of Nazi aggressive policy. In the West, however, the Germans have already made a start on their long trumpeted plan to cut off Great Britain from its overseas supplies by means of a U-boat and bomber campaign in the Atlantic, and this thrust has to be seriously reckoned with.

As regards the Balkans, it seems evident that the war of nerves has not, as yet, secured HITLER all he doubtless hoped to get. True, he is now master of Rumania and Bulgaria, but he has not succeeded in frightening Greece from her so far successful task of defeating the Italians in Albania, nor has he made any impression on Turkey's pro-Ally standpoint. Finally, he has yet to induce Yugoslavia to side with the Axis, and this pugnacious Balkan state seems bent on holding out as long as she can and bowing only to overwhelming force. So the German armies based on the lower Danube may have to attempt, by actual fighting, that conquest of the further slice of European territory which they evidently covet. But their task here is not so simple as that of overrunning a demoralized level country like France. The Balkans are very mountainous, and gorges and narrow valleys are not the ideal ground for mechanized warfare, so if Greece is invaded, her defensive forces, aided by British supplies if not also by British troops, should in theory put up a considerable resistance which may allow time for Turkish policy to develop. The Greeks have at any rate had some useful practice against Italian mechanized attacks in Albania, where MUSSOLINI himself is rumoured to have gone, to urge his legions to mass attack on a wide front, an attack which has so far been successfully smashed by the imperturbable Greeks.

But it is premature to hazard even the theoretic outcome of a German attack on Greece. The weather so far has not been favourable for operations in those parts, and if we are to judge from the German timetable of a year ago, April is a more likely month to start the ball rolling. If Greece herself were the only factor, one would assume that it would be only a question of time ere she was worn down; the history of Finland might easily be repeated. But there is enough anti-Axis force in existence in the Middle East to complicate the actual outcome. Turkey is bound to defend her interests, and she may well deem that a German army on her flanks in Greece is a threat to them. Then the British forces in North Africa, especially if they can wind up the Abyssinian and Eritrean campaigns before the rains come in earnest (a not unlikely achievement), would be largely free to strike in a new quarter. It seems clear on the face of it that the task of pushing Italy out of Tripolitania is not one for the next few months, when the hot season makes it difficult for any but native troops to operate. For mechanized warfare is particularly disadvantageous in a tropical climate. So the British forces may well escape the necessity of fighting on several fronts, and can in that event concentrate on helping to defeat the threatened thrust in the Balkans.

On the Seas.

As we remarked above, the German thrust in the Atlantic is a serious one and will need all the effort and skill of the British Navy and the Coastal air forces to counter. Opinion in the U.S.A. seems to be steadily coming round to the view that American participation in the task is an eventual necessity. But for the next month or two the British effort may well be the only one on the stage; not only do we lack our French allies of the last war, but French ports are the jumping off points of the U-boats and French aerodromes the headquarters of the long-distance

German bombers who seek out ships in the Atlantic and direct the waiting submarines to them, or else bomb them on their own account. On the top of these dangers, stray surface raiders are an ever-present danger and tie up a number of major naval craft that would otherwise be free for convoy duties. But the Navy is steadily adding to its forces both by building and by purchase, and its task, if difficult, should not be beyond the skill of its commanders. This notwithstanding, the country is prepared for a fairly heavy deathroll in ships during the next few months, and imports are bound to be further restricted, till the back of the menace has been broken. But a considerable amount of freight shipping is necessarily engaged on conveying supplies for military campaigns, so must provide a reserve which could be drawn on if essential supplies of food to the United Kingdom were endangered. And in the long run all the omens seem to point to the fact that we can eventually count on the assistance of the United States to lighten our task on the waters. Meanwhile the British belt can be tightened further without much distress.

America's All-out Effort.

The most important event, from an international point of view, that occurred last month was the passing in the American Congress (after a debate unnecessarily prolonged by the dilatory tactics of the few but determined Isolationist leaders) of the Aid-for-Democracies Bill, more popularly known as the Lease and Lend Bill. This clears the way for President ROOSEVELT to "sell, transfer, exchange, lease, lend, or otherwise dispose of" to any country whose defence he deems vital to the defence of the U.S.A. any article required for its defence. The effect of this measure will be not only to accelerate the flow of munitions of all kinds to the United Kingdom, as also to Greece and China, but also to enable the President to dispense at his discretion with ordinary methods of payment. Materials can be lent outright, without any loan in terms of money, under a promise to return the same or other materials required at some future time by the lender. Thus not only does the President get his way to make America an arsenal for democracy but a new chapter is opened in international economics, aimed at avoiding some of the worst consequences of one-way war-time indebtedness, such as the 1914-18 war brought in its train. Mr. CHURCHILL rightly described this new Act as a "monument of generous and far-seeing statesmanship" and said that the United States have in fact written a new Magna Carta for free men and free nations. The immediate consequence is that now the United States is free to go ahead with plans for an immensely increased output of supplies to aid this country in its supreme task of defeating the Axis in Europe and wherever it plans its inroads. These supplies are to include if need be foodstuffs and other agricultural commodities, a shipment of no small moment when it becomes increasingly clear that the German plan of campaign this year comprises a determined attempt by U-boat and bomber to cut off from Great Britain her incoming shipments of food. The American scheme in fact is aimed at supplying this country with practically all aids to war save men, and is the first instalment of a larger plan destined to arm America herself against the inroads of Totalitarianism. We, being her front line, are to get most of the prior deliveries, which are required not to enable us to slacken off in our own efforts but to give us that additional power needed to enable us to get a definite ascendancy over an enemy who has nearly all the arsenals of continental Europe at her enforced disposal. As a distinguished writer in a London Sunday newspaper put it the other day, "the battle for humanity, since Italy betrayed it and France lost it and Russia shirks it, has come to rest on the efforts of the English-speaking peoples and their immediate associates and dependents. No other Power in the world could hold up its head against Germany if the British Empire, backed up by the United States, did not stand in the breach."

Mr. Roosevelt's Call to Action.

A few days after the passing of the Lease and Lend Bill, Mr. ROOSEVELT delivered an epoch-making speech, in which he outlined the causes which had inexorably led to America's material participation in this war and pledged ever-increasing aid till total victory was won. Some points from that speech are well worth setting on record here, since there are few of our readers who are not more or less directly interested in the outcome of this almost world struggle. Even if the production of staple crops can continue much as hitherto in areas remote from the actual hostilities, the actual ownership of some of those crops necessarily lies at stake, while for most of the areas the victory of the Axis New Order would cast all their customary markets in the melting pot and cancel all chance of such social improvement as the sugar industry, for one, has of late years endeavoured to establish.

Mr. ROOSEVELT observed that, whereas in the 1914-18 war the Germans had some reason for thinking that opinion in the U.S.A. was disunited, that they cared more for peace at any price than for the preservation of ideals and freedom, the Dictators must not doubt their unanimity now. "We, as a united nation, realize the danger that confronts us and to meet that danger our democracies have gone into action . . . . . Prussian autocracy was bad enough in the first war, Nazism is far worse in this." "The Nazi forces . . . . . openly seek the destruction of all elective systems of government on every continent, including our own; they seek to establish systems of government based on the

regimentation of all human beings by a handful of individual rulers who seized power by force . . . . . Humanity will never permanently accept a system imposed by conquest and based on slavery . . . . . There never has been, is not now, and never will be, any race of people fit to serve as masters over their fellow-men. The world has no use for any nation, which, because of its size or because of its military might, asserts its right to goosestep to world power over the bodies of other nations and other races."

Mr. ROOSEVELT next proceeded to emphasize that the urgency to help in the cause is *now*, and the administration at Washington are thinking in terms of "speed and speed now." But to carry out that watchword America had henceforward to make sacrifices. "To all it will mean sacrifice on behalf of your country and your living . . . . . a sacrifice of some privileges, not the sacrifice of fundamental rights . . . This is no part-time job. Our differences must be forgotten till the task is finished. I ask you for an all-out effort because nothing short of an all-out effort will win. The light of democracy must be kept burning. Each of us must pool his own strength. There are 130,000,000 individuals over here, and there are many more millions in Britain and elsewhere bravely shielding the great flame of democracy from the black-out of barbarism . . . . . The masses of the British people are completely clear in their minds about the one central fact that they would rather die as free men than live as slaves."

Mr. ROOSEVELT concluded by saying that the British people and their Grecian allies needed assistance, and that they would get. They needed ships, planes, food, tanks, guns and ammunition, and supplies of all kinds. And from America they would get all these. Nor did he overlook China, which "expresses the magnificent will of millions of plain people to resist the dismemberment of their nation. America has said that China shall have our help."

A Matter of Terminology.

A correspondent has drawn our attention to the title of an article originating in Queensland which was reviewed in our December issue, "Alternate Hosts of *B. vasculorum*."[1] A dual exception is taken to this title in the use of the world "alternate" in place of "alternative" and of the specific name "*vasculorum*" in place of "*vascularum*."

It is a moot point whether a reviewer should take upon himself the task of correcting errors which appear in a paper under review. It is not always possible to state with certainty that a word or statement is actually erroneous, and as a general rule the safest procedure is to follow the original except where a misprint is clearly involved.

In the present case it would seem that the word "alternative" is the correct one. As far as we are aware, the word "alternate" was first introduced with reference to the rusts of cereals, and its use should be restricted to those cases where the parasite occurs on two hosts, passing from one to the other and exhibiting differing morphological characters on these. In the case of the rusts, the two forms, occurring on the barbery and cereal respectively, are now known to be the diploid and haploid stages. There is no such distinction in the present case. The fungus is not highly specialized and its single stage ranges indiscriminately over a variety of different hosts. The word "alternative" would be, therefore, more appropriate.

The question of "*vascularum*" or "*vasculorum*" falls into a different category. It is a derivative of the Latin word "*vasculum*" and it would be natural to assume "*vasculorum*" to be correct. Unfortunately, Linnaean terminology is regulated by rules of priority which are neither simple nor take account of derivation. In the present case the organism of gumming disease was first identified by COBB in 1893, who named it *Bacillus vascularum*. In 1901, E. F. SMITH designated it *Pseudomonas vascularum*, while, in 1902, R. G. SMITH made a further change, designating it *Bacterium vasculorum*. Still later, in 1923, BERGEY *et al.* changed the generic name and designated it *Phytomonas vascularum*. This last change has not been accepted and the correct name would appear to be *Bacterium vascularum* (COBB), R. G. SMITH, thus perpetuating the original error of COBB in using a first declension genitive for a second declension word.

Modern usage, however, appears to be singularly uncertain in this matter. A casual search for references in recent literature produced three using *B. vascularum* and two *B. vasculorum*.

Dominican Republic Sugar Trade.

According to a summary in Willett & Gray's Journal, raw sugar in 1939 comprised 63 per cent. of the total value of Dominican exports. The quantity shipped that year was 407,370 metric tons, as against 403,537 tons in 1938, but the value rose from \$8 592,050 to \$11,803,568, the highest total value for Dominican exports since 1929 ; and as the sugar had all been marketed prior to the outbreak of war in September, 1939, its value was not increased by war-time prices. The average price was \$1·27 per 100 lbs., f.o.b., as compared with \$1·00 in 1938 and \$1·12 in 1937. In 1939 France and Morocco took a substantially greater amount of Dominican sugar than during 1938, while the U.K. purchased less. In 1939 the U.K. import was 239,176 tons, that of France 58,097, and that of Morocco 49,731 tons, while 30,469 tons went to U.S.A. and 15,232 tons to New Zealand. A relatively stable level has been maintained during recent years in the volume of the exports of molasses, the average annual amount over a 5-year period approximating to 100,000 tons ; but prices have suffered a drastic decline.

[1] *I.S.J.*, 1940, p. 412.

The Eight Days' Sugar Debate of 1841.

By NOËL DEERR.

On May 7th one hundred years ago began the first concerted attack on the West Indian sugar monopoly. By 1840, in the two centuries during which Great Britain had been a sugar producer, the financial policy of the nation had led to a prohibitive duty on foreign-grown sugar, so much so that in that year the duty on foreign sugar, slave or free grown, had reached 66s. per cwt., that on colonial grown being only 25s.

The first challenge to this monopoly was made in 1840 by a private Member of Parliament, WILLIAM EWART, whose motion, to reduce the duty on foreign sugar to 34s., was rejected by the Melbourne Ministry on the score of principle, the vote in the House being 122 to 27 against EWART'S motion. Notwithstanding, in the very next year principle was avowedly subordinated to expediency, in order to meet an anticipated deficiency in the Budget of £700,000, through the stimulus to consumption by the lower price expected from a reduction in the duty on foreign sugar to 36s. The duties on corn and on timber were also to be reduced, but the debate centred entirely on the sugar duty.

This proposal split the House into three camps: the Whigs, already under the influence of COBDEN, not yet a Member; the Anti-Slavery party, of which LUSHINGTON was the *doyen* and which included many Whigs; and, thirdly, the Tories, embracing the still powerful West India interest.

To meet this proposal, VISCOUNT SANDON moved an amendment, seconded by JAMES WEIR HOGG, Chairman of the East India Company and the father of QUINTIN HOGG, which ran ". . . . considering the efforts and sacrifices which Parliament and this country have made for the abolition of the slave trade and slavery, with the earnest hope that their exertions and examples might lead to the mitigation and final extinction of those evils in other countries, this House is not prepared (especially with the present prospects of supply of sugar from British possessions), to adopt the measures proposed by Her Majesty's Government for the extinction of the duties on foreign sugar."

The debate was opened by LORD JOHN RUSSELL, Secretary for the Colonies. He contrasted "the distress in the industrial north with the comforts enjoyed by the negroes in Jamaica" and taunted the West Indian party ". . . . you now come forward for a party purpose with an affectation of humanity to which your past conduct does not give you a just title." To this VISCOUNT SANDON made reply by asking LORD JOHN "what right had he to deny to him and those who supported the amendment the same regard for the interests of humanity which actuated the Government."

DR. LUSHINGTON was the first of the old Anti-Slavery party to speak. He condemned the proposal because it gave a stimulus to the slave trade, because it was unjust to the emancipated labourer and to the capitalist, and because it was unnecessary to adopt this course to supply the people of England with sugar. He thought, too, that the industrial north would prefer a dinner of herbs to the stalled ox offered by the Government; to which Mr. EWART replied that the rich man would still have the stalled ox, while leaving the herbs to the poor man.

Mr. W. E. GLADSTONE, after a tribute to the memory of ZACCHARY MACAULAY, said: " I am at a loss to know what rational motive could have induced the Government to mix with a general question of trade another question which the people of England are determined to entertain upon a basis of humanity. I can only ascribe it to that infatuation, which is often found accompanied by lack of principle " To this indictment THOMAS BABBINGTON MACAULAY, then Secretary of War, at once replied He repudiated any laxity of principle and charged the amendment with being "a skilfully contrived party motion, the object of which was to perplex and dispossess the advisers of the Crown, without committing their successors. . . . . What was this principle which allowed a man the enjoyment of a cup of slave-grown coffee, but did not permit him to sweeten it with slave-grown sugar."

Shortly after this passage of arms, VISCOUNT HOWICK intervened in the debate. He referred, as if proven, to the charge of inhumanity on the Vreed-en-Hoop estate he had brought against JOHN GLADSTONE in 1833. To this both THOMAS and WILLIAM EWART GLADSTONE had replied, the latter in his first set speech in the House. Now to his statement that "Vreed-en-Hoop[1] was remarkable both for the large produce of sugar and for the rapid diminution in the number of slaves, in three years no less than one-seventh of the whole number . . ." JOHN GLADSTONE *fils* replied: "Taking into consideration the difference in the power of the machinery employed, I beg leave must unequivocally, distinctly and broadly, to deny that part of the noble lord's statement."

After a number of members had spoken of the advantages of trade with Brazil, Mr. GOULBURN, who had been Chancellor of the Exchequer in 1828 under the DUKE OF WELLINGTON and was again to hold the same post in Sir ROBERT PEEL'S ministry, said: "There was a possession of the Crown not inhabited

[1] Vreed-en-Hoop lies at the mouth of the Demerara river on the west bank. It was at this estate in 1832 that the first colonial vacuum pan was installed. Later this estate became amalgamated with Windsor Forest, which continued in operation till about 1907.

like Brazil by 6,000,000 people of whom half were slaves, but inhabited by a free people of 100,000,000 in a state of great civilization, possessing rivers perhaps not equal to those of Brazil, but extending through a country as fertile and opening up avenues to numerous nations, with means as ample for making returns for the productions and manufactures of this country. He need hardly say that the country he alluded to was India." He was followed by Mr. CHARLES BULLER, who asked "for whose benefit were protective duties to be imposed? Would they be any benefit to the labourers of the East Indies? If there were any curse they could impose on that country it was by diverting labour into channels such as these. They would be inducing the people of India to enter into competition with other colonies under protective laws." He concluded: "In the name of the people of India do not inflict this curse upon us."

Sir ROBERT PEEL did not speak till late in the debate. He opposed the motion to reduce the foreign duty, saying that "it would not be for the honour of this country to open our market to sugar, the produce of slave labour." Referring to India, and especially to the views of Mr. BULLER, he said: "Remittances are required from India to the extent of £3,200,000 yearly . . . . the faith and honour of the British Parliament, the faith and honour of the country itself, are concerned in the maintenance of the exclusion of slave-grown sugar. If, then, I encourage the produce of India shall I be told I am inflicting an injury on this country or on India?"

VISCOUNT PALMERSTON closed the debate in a speech of exquisite irony which accepted facts without consenting to the causes underlying the facts. His argument ran: "We say to these Brazilians, we can supply you with cotton goods cheaper than you can buy them elsewhere. Will you buy them? By all means, say the Brazilians, and we will pay you with our sugar and coffee. No, say we, your sugar and coffee are produced by slave labour; we are men of principle and our conscience will not allow us to consume the produce of slave labour. Well, anyone would imagine the transaction ended there, and we left the Brazilians to consume their own sugar and coffee. No such thing. We are men of principle, but we are also men of business, and we try to help the Brazilians out of their difficulty. We say to them: Close to us and near at hand live some 40,000,000 industrious and thriving Germans, who are not as conscientious as we are; take your sugar to them and you can pay us for our cottons with the money you thus receive. But the Brazilians represent there will be some difficulty in this. The Germans live on the other side of the Atlantic; we must send them our sugar in ships; now our ships are few and ill-fitted to cope with the waters of the mighty ocean. Our reply is ready. We have plenty of ships and they are at your service. It is true that slave labour sugar would contaminate our warehouses, but ships are different things. But the Brazilians have another difficulty. They say the Germans are particular and have a fancy for refined sugar. It is not easy to refine sugar in Brazil, and these Germans do not like the trouble of refining it themselves. Again we step in with an expedient. We will not only carry your sugar but we will refine it too. It is sinful to consume slave-grown sugar, but there can be no harm in refining it, which is, in fact, to cleanse it from part of its original impurity. The Brazilians are at us again. Say they, we produce a great deal more sugar than the Germans will buy. Our goodness is infinite; we ourselves will buy your surplus. It cannot be consumed at home because the people of this country are men of conscience, but we will send it to the West Indies and to Australia. The people who live there are only negroes and colonists, and what right have they to consciences? And now that you may plague us no more about these matters we tell you at once that if the price of our own sugar should rise above a certain value we will buy more of your slave-grown sugar, and we will eat it ourselves."

Nevertheless, VISCOUNT SANDON'S amendment was carried by 317 votes to 281. In the majority were DISRAELI, GLADSTONE, Sir ROBERT PEEL, LORD GEORGE BENTINCK, Sir STAFFORD CANNING, LORD STANLEY, LUSHINGTON, GOULBURN, and the solid block of West and East Indian interests united with the anti-slavery party. In the minority were LORD JOHN RUSSELL, VISCOUNT PALMERSTON, VISCOUNT HOWICK, MACAULAY, VISCOUNT MORPETH, FRANCIS BARING and C. P. VILLIERS. Only 19 members were unpaired or failed to vote.

Seldom have so many illustrious names appeared in one debate. To that of PEEL, who had already held the highest office of state, can be added those of five Premiers-to-be, STANLEY (Earl of Derby), LORD JOHN RUSSELL, PALMERSTON, DISRAELI and GLADSTONE, and with them appears the no less illustrious name of MACAULAY. Afterwards in the Parliament that reversed the verdict of 1841 are to be found those of COBDEN and of JOHN BRIGHT.

The victory won here afforded but a temporary arrest to the flood of free trade. In 1846, after the defeat of PEEL on the Irish Coercion Bill, LORD JOHN RUSSELL became Premier, and at once announced that the Government was pledged to the equalization of the duties on sugar "of all sorts, of whatever growth and whencesoever imported." An amendment moved by LORD GEORGE BENTINCK was rejected by 265 votes to 135, after Sir ROBERT PEEL, now a private member but still having great influence, had withdrawn his opposition. It is worth while noting that among the majority were VISCOUNT SANDON and Sir JAMES HOGG, who had led the opposition in the eight days' debate.

Safety First.

There are plenty of opportunities on a large sugar plantation for accidents to occur in the field whether in the handling of the more complicated implements now commonly in use or of the simpler tools such as cutting knives and hoes. While on most plantations care is now taken for the health of the resident labour in the adoption of standards of residential accommodation, sanitation and prevention of disease, less attention has been given to the subject of safety measures against accident. That statement may require qualification, for it is dangerous to write without the book, and it would be safer to say that the subject of safety in the field and factory has not formed the subject of discussion or literature in the past. A welcome break in this silence has recently been made by S. M. MILLER, who, under the heading of "Safety in the Field," described the methods adopted in Hawaii in a paper presented to the third meeting of the Hawaiian Sugar Technologists in November, 1940, and appearing in the Reports of that meeting. The organization that is being introduced is in process of evolution and, as would be expected, has been carried to a more advanced stage on some plantations than on others. The paper here reviewed summarizes the information collected by a questionnaire submitted to all the plantations, with most frequent reference to that at Ewa.

The most numerous accidents in the field are injuries to the eyes and cuts from cane knives. Prevention against these is given by goggles, safety shoes and leggings as personal clothing, while the hoes and knives are provided with guards. For work with fertilizers and chemical weeding, respirators, rubber boots, chaps and ponchos additional to goggles are also worn. The major difference in plantation practice lies in the extent to which the wearing and use of these is enforced. On some plantations use is mandatory and, in these cases, personal clothing is supplied at cost and other equipment free. A measure which is now routine on many plantations is the periodic physical inspection of the personnel of the chemical weed gang; by this measure labour unsuited for the handling of the standard herbicides is eliminated and set to other work. Prompt treatment and report of accidents are insisted on and, for the former object, a small first-aid kit may be issued to each gang. But no risks are taken and, where such is the case, the labourer whose skin has been cut or broken, must report to the hospital. As the result of such action, one plantation reports that the number of accidents reported has increased—a not unnatural result—but that the loss of time through accidents has decreased.

It is impossible here to recount all the points, small in themselves but in the aggregate productive of appreciable results, of the measures adopted by the different plantations, for each of these is feeling its way in the matter. At the present stage it is essentially a question of experiment. A few examples only may be quoted. On one plantation a decrease of accidents is reported from the standardization of the position of the brake handles on cane cars. On another, canvas bags are provided for the carrying of cane knives; on a third, hoes are not allowed in the trucks but are carried in special racks on the outside of the car.

All these measures are to the good but they will avail little if they are not enforced. In such matters there are two methods of enforcement, the one by punishment, the other by encouragement. There can be little doubt which is the better method in cases like the present; it is not a question of checking wilful disregard but of creating a new atmosphere and of overcoming inertia. That is the view adopted in Hawaii, the major effort being directed to stimulate the interest of all down to the individual labourer. To this end workmen's safety committees are organized with representatives from each of the field gangs, service being for one year with one half changed every six months thereby maintaining continuity. Supervisors' safety committees are organized in the same manner and all these committees elect their own chairmen and secretaries. Meetings are held every two weeks or monthly; more frequently in the initial stages.

Above these is a central safety committee composed of one representative of each of the above committees plus the factory superintendent, field superintendent, agricultural and harvesting department heads, and the plantation doctor. The chairman of this committee functions as safety director and liaison officer between the committee and the plantation manager. The function of the central committee is to consider suggestions received from the subordinate committees and to pass on recommendations to the manager.

As has been stated, the primary appeal is a stirring of an interest, but that alone is not sufficient. A certain authority is required to ensure the enforcement of the decisions arrived at, and this is given by "safety committeemen's" badges which are worn at all times during work. Second only to the stirring of interest is its maintenance. Here the human factor comes in, and the load falls on the manager without whose interest the interest of others will not be sustained. Various suggestions are made to achieve this end, not the least of which is the prompt and sympathetic handling of all recommendations received from the workmen's committees and a reporting back to these of the action taken. Membership of the National Safety Council Inc. is another proposal, ensuring a supply of the monthly publication, *The Safe Worker*.

A further step has been taken at Ewa plantation in the organizing of safety contests between the gangs. The first to be organized was between the hand-spray gangs, and the result was decided by

monthly inspections at which marks were given, 35 per cent. for condition of equipment, 15 per cent. for condition of station, 25 per cent. for quality of work, 10 per cent. for protective apparel, and 15 per cent. deducted for lost time through accidents. Later a similar contest was organized among the harvesting teams with results again based on inspections, but at fortnightly intervals. The basis for this was: condition of machines and equipment 25 per cent., condition of field after harvesting (including close cutting of stubble, care of ditches and irrigation equipment and non-furrowing of field by grab) 50 per cent., and accident record (including non-wearing of safety goggles) 25 per cent. Prizes are allotted to the winning teams as judged by two or three inspections, and these include free tickets for the cinema to each member of the team with their families, free chop suey dinner to the winning team on the final result of the harvesting season and an emblem on the cab of the machine.

Here, again, the various plantations are showing a commendable zeal in feeling a way to maintain interest. On one plantation points are given for safety endeavours and the foreman's pay is affected by the result. On another a safety score is kept, based on the relation between the number of accidents relative to the number of hours of supervision. In this latter case it would have been of interest to learn whether such a method does not lead to failure to report cases to the hospital.

In another instance the desired interest is fostered by a portable safety display show-case containing the various safety devices and moved through the villages and mill. This idea has been developed on the Ewa plantation, where a permanent display case has been erected near the administrative buildings and on which much thought has been given. The roofed structure is provided with a clock and is illuminated. Besides the exhibits of safety devices, it displays a daily record of accidents under the three group headings: factory and shop, harvesting-planting-transportation, and agricultural. In this display a green light indicates freedom from accident on that day and a red light an accident. The record is kept posted daily for a month when a fresh record is started.

H. M. L.

Bureau of Sugar Experiment Stations, Queensland.

Fortieth Annual Report, 1939—1940.

The conditions controlling the year's results were a very dry spring followed by an exceptionally wet rainy season, and in the South a prolonged dry autumn followed by damaging frosts. In the result, especially in the North, an early drought-stricken appearance was succeeded by damage from water-logging. Cane on the higher lands benefited, but, here again, disadvantage resulted from widespread free arrowing. Despite these handicaps, the estimated crop was surprisingly good—5,857,700 tons—second only to the previous crop, which constituted a record at 6,038,821 tons. The yield of raw sugar was estimated at 810,000 tons against the record of 891,422 tons of the previous year. Several records were broken in the 1939 season. Cane crushed per acre amounted to 23·1 tons with an average yield of sugar per acre of 3·41 tons, and both these figures have shown an almost continuous rise since 1930, in the former from 15·89 tons and in the latter from 2·33 tons. The figure for tons of cane per ton of sugar in 1939 was 6·77, and here, too, a slight downward trend is apparent.

Northern Station, Meringa.

At the Meringa Station the contrast between the wet and dry seasons was particularly marked since only 3·63 inches of rain fell during the last six months of 1939, whilst 65·91 inches fell in the first three months of 1940. The early growths, thus, were drought stricken, and later the crops on lower ground became water-logged. On the higher lands, however, satisfactory growth took place and, in general, yields were only slightly below the average. In February a cyclonic disturbance flattened the cane, but owing to its backward state less damage than might have been expected resulted.

A single variety trial was harvested in which five of the G series and one of the H series were compared with SJ 4. The two heaviest yielders, G 140, with 38·0 tons cane per acre and c.c.s. 16·8 per cent. (SJ 4, 32·6 tons and c.c.s. 17·0 per cent.) and G 118 with 37·4 tons and c.c.s. 14·5 per cent. were eliminated, the first on account of a high susceptibility to leaf scald, the latter on account of bad habit and low sugar content. The four remaining, G 113, G 126, G 243 and H 248, have been carried to a Latin Square trial. A few sets only of a considerable number of newly released varieties have been planted out for the 1940 season.

The search for valuable leguminous crops with a view to broadening the basis of the agricultural practice was continued. Among the promising crops were *Crotolaria usaramoensis*, which appeared of more than usual promise, *C. anagyroides* with good growth but rather woody, *Phaseolus riccardianus* and *P. trinervis*, and, lastly, *Pueraria javanica*, which pro-

duced an abundant crop of green matter and, not flowering till late May, should be of special value to growers requiring the protection of a green crop till late. Among the Sorghums tried as a substitute for maize, ruled out for its susceptibility to downy mildew, Schrock was definitely outstanding. Brazilian lucerne (*Stilosanthes guyannensis*) yielded well on poor forest country and may prove valuable on poor-land grass paddocks.

CENTRAL STATION, MACKAY.

At the Mackay Station the trend of the season followed that of the Northern Station, but the dry season was not quite so intense and the rains were more extended, commencing in December and continuing into April. The experimental work with cane included variety trials, both Latin square and observational, and downy mildew resistance trials. In the former, Q 28, E 4, E 45 and Comus, a seedling propagated by the C.S.R. Co., were compared with Q 813 as standard. Q 28, with 41 tons cane per acre and c.c.s. 14·3 per cent. (Q 813, 30·1 tons and c.c.s. 16·2 per cent.) was the heaviest yielder and is considered a possibility for poor lands. Comus (36·0 tons and c.c.s. 16·2 per cent.) shows promise but is decidedly susceptible to mosaic.

A number of canes of the F and G series was compared with Q 813 in the observational test and also included in the downy mildew resistance trials, as the result of which latter only four survived for promotion to a Latin square test. These are: G 17 with 48·3 tons and c.c.s. 13·9 per cent. (Q 813, 33·8 tons and c.c.s. 15·4 per cent.), G 22 with 42·5 tons and c.c.s. 13·8 per cent., G 39 with 39·8 tons and c.c.s. 15·9 per cent., and, lastly, G 58, the heaviest yielder of all, with 49·8 tons and c.c.s. 17·2 per cent.

The attempts which are being made to broaden the agricultural basis in Queensland are illustrated at this Station by a rotational experimental block on sections of which green crops are grown for ploughing in, while, on others, sheep are grazed. It is held that the suitability of the coastal lands for sheep grazing has been established. The more promising legumes are *Dolichos lab-lab*, *D. debilis*, *Phaseolus riccardianus* and *P. trinervis*.

SOUTHERN STATION, BUNDABERG.

At the Bundaberg Station the weather was, again, far from favourable. A dry if not very cold winter was followed by fair precipitation till the end of March when a severe drought set in till the end of the year (June), the total rainfall from July to June being 41·01 inches. The high production recorded is attributed to the practice of growing stand-over cane and the varieties now being grown.

A Latin square variety trial, in which Comus, C 12, E 14 and E 18 were compared with Co 290 (plant canes), showed the standard to be the highest yielder, though E 14 ran it very close with 28·3 tons and c.c.s. 17·2 per cent. (Co 290, 29·1 tons and c.c.s. 15·5 per cent.). In an observational plant cane trial several varieties of the F series were compared with Co 290. In this, some of these outyielded the standard; F 20 with 28·1 tons, F 21 with 26·2 tons and F 23 with 26·0 tons (Co 290 with 25·6 tons). Since the plots were harvested immature, the c.c.s. percentages were all low.

In a Latin square trial comparing Q 22 to Q 25 with Co 290, plant and first ratoons, the outstanding variety was Q 25 with 78·2 tons for the two crops and c.c.s. 16·0 and 17·2 per cent. plant and first ratoon respectively (Co 290 with 70·2 tons and c.c.s. 14·3 and 15·2 per cent.). The promise of this is such that 800 tons of planting material has been rendered available for farm propagation plots. It is highly resistant to gumming and downy mildew but somewhat susceptible to Fiji disease. First ratoon observational trials compared a number of varieties of the E series with Comus and Jason. The only two to be carried forward are E 12 (now Q 42) and E 14 (now Q 43). Both are resistant to the three major diseases, but the former is probably too susceptible to mosaic. A further first ratoon variety trial compared POJ 213 with Co 290. The slight difference between the two appears to depend on the season. In a second ratoon trial, POJ 2875 has, for the third crop, surpassed all other yields, but its c.c.s. is low. POJ 2883 has performed uniformly well and would be added to the approved list but for the disease position.

A first ratoon fertilizer trial with 0, 1 and 2 doses of N, P and K (dose = for N 120 lbs. sulphate of ammonia, for P 400 lbs. superphosphate, and for K 180 lbs. muriate of potash per acre) gave no effect on yield for any dressings. On the c.c.s., however, potash has a marked lowering effect, while phosphate acted in the reverse direction. These effects are attributed to the action of potash and phosphate in advancing and retarding maturity respectively.

In an experiment comparing trash with no trash carried to the second ratoons, heavier crops continued to be reaped from the trashed plots, but the increase was smaller than expected owing to the higher mortality of stools in the trashed plots.

SEEDLING PROPAGATION.

The major difficulty in raising seedlings lies in the fact that it is only in the far north, in the wet tropical section of the cane belt, that cross-pollination can be effected with any success. The supply of seed is thus largely controlled by the nature of the season. In this work the Hawaiian solution of 0·01 per cent. SO_2 and a like concentration of H_3PO_4 has been found most satisfactory, except for early arrowing varieties when the concentration of SO_2 is doubled. Lanterns have been adopted but of a somewhat different shape to those used elsewhere, being permanent with the crosses brought to them.

To meet the difficulty of seasonal variation in the freedom of arrowing and, hence, in the quantity of fuzz produced, experiments in the storing of fuzz have been carried out for a number of years. It has been found that fuzz can be successfully stored in the majority of cases over calcium chloride at a temperature of 43°F. So treated, the fuzz from late crosses can be sown prior to the sowing of the fuzz of early crosses of the following year. Also it was found that, by the simple expedient of removing the blades of all green leaves a few inches above the growing point and repeating the process as necessary, the arrowing of the early free-flowering POJ 2364 and POJ 2725 could be delayed so as to make the arrowing of these synchronize with that of the later flowering varieties.

During the year the two varieties Q 10 and Q 20 were released for general planting in the Northern and Central districts respectively. Extensive plantings of Q 25 (POJ 2875 × HQ 409) were made for later general planting in the Southern districts.

The 1940 season was generally favourable and a number of crosses was effected, in some cases the parents being recent seedlings of the J, JB and K series. Nobilizations of *Saccharum spontaneum* and *Erianthus arundicearum* were also attempted. Of the 1939 seedlings some 21,000 were planted out covering a wide range of families. These crosses included a considerable number in which Badila appeared as a parent, and the general conclusion is drawn that Badila × noble progenies are not very promising and that it will be necessary to incorporate some wild blood. Of the 96 seedlings selected from the 1938 series at Meringa more than half were from families represented by Badila and SJ 4 crossed by half nobilized *S. robustum* (28 NG 251). At Mackay *robustum* seedlings and POJ 2725 × Co 290 formed a prominent part of the 70 seedlings carried on, and at Bundaberg the outstanding combination was POJ 2878 × Co 290.

A list of second selections at the three stations is given under the pre-farm lettering. To eliminate the confusion arising from this lettering indicating not only the year of origin but the Station, a new terminology is to be introduced, commencing with the 1939 series. In this A 1 to A 100 are allotted to seedlings of this season raised at the Bundaberg Station, A 101 to A 200 to those raised at Mackay, and A 201 + to those raised at Meringa.

A statistical statement is given by districts of the areas harvested of the different varieties. Badila still maintains its lead with 33 per cent. of total crop, but POJ 2878 has come to occupy second place (12·21 per cent.), M 1900 dropping to third place (11·96 per cent.). D 1135, formerly the standard cane, now occupies less than 1 per cent. of the area. Noteworthy, too, is the fact that Queensland-raised seedlings occupy some 20 per cent.

ENTOMOLOGY AND PATHOLOGY.

The stricter control resulting from the amendments to the Sugar Experiment Stations Acts, is noted as leading to benefits which are becoming obvious.

The Greyback Beetle (*Lepidoderma albohirtum*).—A rapid increase, leading to serious loss, was recorded in the North. This increase is attributed, not to lack of desire to use, but to inability to obtain the necessary fumigants owing to the war. Improvements in method are recorded in the Blundell knapsack injector and the Mourilyan 3-unit carriage machine which, carrying a flood-lighting set, admits of night working.

Clearing projects, involving those trees on which the beetles feed, appear to have justified themselves. Originally started on the Basilisk range, they are to be extended.

In the Mackay area infestation was comparatively light and the local Pests Control Board concentrated on fumigation, ceasing payment for the collection of beetles. In both areas, however, the varietal position has a large influence on the extent of the damage. In the Northern area the resistant SJ 4 has been eliminated from the Mulgrave and Hambledon areas as a consequence of its susceptibility to gumming disease. Under wet conditions POJ 2725 is moderately resistant, POJ 2878 and Co 290 are less resistant but superior to susceptible varieties such as Badila, Q 10 is susceptible, but Q 29 appears unattractive. In the Mackay district, on the other hand, POJ 2878 is counted as resistant with POJ 2714, EK 28 intermediate, and such varieties as M 1900 seedling, Badila, Q 813, Q 20 and SJ 2 susceptible.

The Beetle Borer (*Rhabdocnemis obscura*).—During the year the attack was only moderate. The incidence appears to be associated with that of top rot.

The Sugar Cane Scale (*Aulacaspis madiunensis*).—Severe infestations occurred in the Bundaberg district. The development of a pest known to have led a comparatively harmless existence since 1918 appears to be associated with the change in agricultural practice, especially the increased practice of leaving stand-over cane, which now constitutes a large percentage of the crop. POJ 213, and, to a less extent, POJ 2878, are the worst affected, with POJ 2725 and Co 290 fairly resistant. The elimination of POJ 213 and burning are recommended.

The Giant Toad (*Bufo marinus*).—In many of the Northern areas saturation point appears to have been reached. The evidence suggests that, in spite of this, its value as a check on the greyback beetle is slight and it is probable that its major effect will be in the control of the beetle borer.

Gumming disease (*Bacterium vasculorum*).—A detailed account of this disease has appeared in a recent issue.[1] The Mulgrave, Hambledon and Moreton districts alone reported attacks. The remedy, as has

[1] *I.S.J.*, 1940, p. 412.

been explained, lies in the selection of resistant varieties and, in the last of these districts, the removal of the susceptible HQ 285 in 1941 from the approved list is expected to prove beneficial. In the first district the elimination of SJ 4 is expected to have a like effect, but a certain anxiety arises from the extension of the disease to the more resistant Badila and HQ 409. In Hambledon, where a really satisfactory alternative to SJ 4 has to be found, a considerable spread of the disease occurred. Here SJ 4 predominates, and to avoid hardship the variety remains on the approved list for 1940.

In the gumming trials Co 515, a POJ 2725 × Sorghum cross, suffered more damage than the standard susceptible varieties. Q 13, Q 20 and the Hawaiian cane 31-1389 appeared highly resistant, Q 10 commercially resistant, and Q 2, Q 26 and Q 27 too susceptible for South Queensland conditions.

Fiji disease.—This disease is rapidly being brought under control through the intensive campaign of inspection. Here, again, it is largely a question of varieties. Trials have demonstrated that POJ canes, while transmitting susceptibility to a large proportion of their offspring, do yield some highly resistant seedlings. Completed trials show that the Co's 352, 355 and 356 carried no infection, Q 42, Q 43 and Q 813 infection up to 10 per cent., Q 2 and SC 12/4 between 10 and 20 per cent., and POJ 2878 and D 1135 from 20 to 40 per cent.

Downy Mildew (*Sclerospora sacchari*).—The rise of this disease to a position surpassing that of all other diseases found in Queensland and the general lines on which the incidence is being met have already been described. The whole problem illustrates well the difficulties arising in a country in which the conditions are so variable that varietal adaptation, leading to local concentration of different varieties, plays an important part. Each district offers a different aspect of the problem and these are reviewed in the present report. The Disease Control Boards are meeting the situation by the combination of ploughing out orders, by the prohibition of susceptible varieties as soon as a reasonable alternative is found, and by the prohibition of alternative hosts, especially maize. A few points of especial interest only can be mentioned here.

In the "North Coast" section of Mackay POJ 2878 has proved of particular value owing to its resistance to grub attack; but it is among the most susceptible varieties to downy mildew. Field observations indicate that the spread can take place over a greater distance than previously supposed, possibly up to one mile. Resistance trials carried out at Cairns, Mackay and Bundaberg included a large number of varieties of which POJ 2878 was the most susceptible. The resistant varieties included Q 13, Q 20, Q 29, Badila, HQ 409, HQ 458, Co 515 among others, and *Erianthus*. POJ 213 alone showed a marked difference in susceptibility at different localities. Hot water treatment of sets proved efficacious with exposure for 20 minutes at 54°C. or for 10 minutes at 56°C.

Chlorotic streak.—The incidence of chlorotic streak remains as in previous seasons. Treatment of the sets with warm water constitutes the major control. The problem here is complicated by the suppression of the symptoms which may occur. Treatment of pre-heated sets immersed for 20 minutes at 44°C. appeared effective. Attempts to localize the area of infection within the cane suggest that it is not limited to the bud. In these experiments it is of interest to note that the longitudinal conducting power of the cane stalk is very low. The date of ratooning appears to influence the incidence of the subsequent attack, for a 12 per cent. incidence in October-ratooned cane rose to 40 per cent. for November. Late planted cane, too, seems more susceptible on ratooning than early planted.

Leaf Scald.—The extended plantings of Oramboo, a gum-resisting variety, in the North have led to an extension of leaf scald. Resistance trials indicated that Jason (6 per cent. infection), D 1135 (7 per cent.) and *Erianthus* are resistant; Badila (42 per cent.) and HQ 409 (45 per cent.) intermediate; and HQ 426 (92 per cent.) susceptible.

H. M. L.

Jamaica Sugar Crops.

According to the Report of the Jamaica Dept. of Science and Agriculture for the 15 months ending March, 1940, the output of sugar in the island for the 1939 crop (January to June) was 117,879 tons. The sugar quota for that crop was originally fixed at 94,390 tons, with an export quota of 80,360 tons, but the latter was later increased to 109,960 tons. Actual exports amounted to 106,000 tons and fetched an average price of 190s. per ton f.o.b. The island quota for the 1940 crop was fixed at 128,100 tons, of which the export quota was 102,000 tons. But owing to the drought in 1939, the Report states, the 1940 crop was not expected to exceed 112,000 tons of sugar, after an original estimate of 123,500 tons. Actually, according to the latest figures, it only reached 99,321 tons. Production in the current (1940-41) crop is estimated at some 148,000 tons.

The weather experienced during most of 1939 was abnormal. Though total rainfall figures were in excess of the average annual total for the last 60 years, distribution was extremely poor. There was continued drought over almost the entire island from March to October, followed by flood rains and a hurricane at the beginning of November. This hurricane, incidentally, uprooted about 75 per cent. of the bearing banana trees, and the canefields also sustained some loss.

Pre-Harvest Burning of Sugar Cane.

By ARTHUR H. ROSENFELD, Consulting Sugar-Cane Technologist, Cairo, Egypt.

It is common practice in a number of sugar countries, such as Hawaii, Peru and Natal, to burn the trash off the cane before harvesting; and experience in all of these countries has shown that in this way the costs of cropping may be materially reduced without any deterioration in the juices of the cane if the latter reaches the mill within 48 hours at the most after burning. In general, after this period of time has elapsed, deterioration is considerably more rapid in burned than in unburned cane, and, in countries where burning is the usual practice, burned cane over three days old is not accepted at the mills.

In other countries, such as Cuba and Puerto Rico, pre-harvest burning is never encouraged, and in the latter country, where disastrous accidental or incendiary cane fires are fairly common, the mills absolutely refuse to receive burned cane, even their own, after a few days have elapsed. Undoubtedly this rigorous attitude has arisen from the fact that, after large areas have been burned over, there is a great tendency on the part of the growers to attempt to deliver this cane long after serious inversion has manifested itself.

The practice of pre-harvest burning, either before the cane is cut where the leaves are dried after a frost, or by cutting the cane, laying it across the middles and burning as soon as the leaves have dried sufficiently for that to be done, began to come in vogue in Louisiana in 1929, in which year the cane obtained a very high degree of maturity quite early in the season. Under the conditions of that year, particularly before the serious freezes of early December necessitated windrowing and unfavourably affected the juices of the cane left standing, this economical aid to harvesting gave excellent results, and the practice became increasingly popular in the two succeeding crop years when, however, the sucrose contents and purities of the juices were rather generally quite low, due to short growing seasons and serious summer droughts. Observations during the later two years indicated that, under such conditions of inferior juices, inversion is more rapid after burning, and also that the point at which these juices become practically unmanufacturable is so close to the normal composition of the juices in such years that a comparatively small drop in sucrose content and purity may represent much more *proportional* deterioration than a similar or even slightly greater loss in riper cane.

In 1930 few controlled data along this line were available, but in 1931, the last crop before he left Louisiana for Egypt, the writer was able to secure the results of several carefully controlled trials on a large scale with burned and unburned cane of the same varieties and age, cut and sent to the mill at approximately the same time. In these tests four or five squares of cane, sufficient to produce from 75 to 100 tons of cane, treated in each way, were used, and the data obtained from the mill runs of each type worked out to the yield of 96° sugar per ton of cane and per acre, as well as to the yield of blackstrap molasses. The writer does not feel that a sufficient number of these tests was carried on, with all the necessary precaution against error, to justify giving the actual figures obtained from each, since considerable additional work should be done along this line, with juice of both low and high purities and sugar contents, before any definite idea of the border line, where burning will pay and where it will not pay, may be obtained.

It was rather evident, however, from the 1931 figures, that with juices running as low as 11 per cent. sucrose and, say, 77 purity, there is a loss in the recoverable sugar through burning more than sufficient to offset the economy in harvesting as a result of this process. The slight increase of one half to three-quarters of a gallon of blackstrap molasses per ton of burned cane under current molasses prices is but a fractional compensation for the loss of around 5 lbs. of 96° sugar per ton of cane which these 1931 tests indicated to be about the average with burned cane.

From the strictly agricultural point of view, if trash were going to be turned under and not burned, as is most generally done in Louisiana, pre-harvest burning would signify some loss of humus. There is no question, however, that burned cane can be harvested much more cheaply than unburned, so that the whole question resolves itself into one of whether the economy in harvesting will more than offset any possible decrease in the value of the burned cane, since the generally advanced practice in that State of turning under a good legume crop before each cane planting will far more than offset a loss in humus through failure to turn under the trash.

It was formerly thought that burning before harvesting destroyed a great many injurious insects, but, inasmuch as the principal cane insect enemy, the borer, is generally well within the tissues of the cane at harvest time and no considerable number is likely to be injured by a quick fire, this factor is probably of comparatively small importance.

A decade ago several Louisiana producers who were interested in direct white sugar advanced the opinion that cane should not be burned where such sugar is to be produced. The experience of Peruvian factories, which produce white sugar in areas where the pre-harvest burning of cane has been practically

universal for generations, would seem to indicate that this phase of the problem need not be a source of worry. It has been proved in these factories for years that perfectly good white sugar can be made from the juices of burnt cane provided this cane reaches the factory not later than 48 hours after burning. As a matter of fact, it generally reaches the factory in Peru within 24 hours[1] and there is abundant evidence to support the general view in that country that burned cane not over 24 hours old yields a crusher juice of higher purity than trashed cane.

Some interesting investigations by L. DOMINGUEZ in Puerto Rico indicate that cane subjected to fire while standing loses weight more rapidly than trashed cane, this amounting in storage to about 1 per cent. per day on the original cane weight, as against around one-third that percentage for unburned cane. Inasmuch, however, as all cane which has been burned before harvesting should, as above stated, pass through the mills within 48 hours, if possible, and never later than 72 hours after burning, this increased percentage loss in weight can be regarded as negligible.

Indian Sugar Production.

The 1939-40 Modern Sugar Factory Season.[2]

Estimates made in the Spring of 1940 assumed that the production of sugar directly from cane in modern factories in India during the 1939-40 season would be about 1,170,000 tons. Actually the production during the season is now known to have reached 1,240,000 tons. This is the highest production ever attained by the cane sugar industry in India and exceeds the previous record of 1,110,000 tons in 1936-37 by nearly 12 per cent. and the productions in 1937-38 and 1938-39 by 33 and 91 per cent. respectively.

The reasons for this record output were that (*a*) a greater number of factories (145) worked than ever previously, though only two of them were new factories; and (*b*), although the season was only of normal duration, factories generally crushed more cane in 1939-40 than in any previous season, owing to the abundance of cane offering. The average quantity of cane crushed by the factories per working day was 710 tons, against 630 tons in 1938-39 and 1936-37, and 660 tons in 1937-38. The high sugar prices ruling in the beginning of the season and the high minimum prices fixed in consequence for cane in the U.P. and Bihar diverted to the sugar factories large quantities of cane that would normally be utilized for making gur. The cane price reduction effected in April came too late to affect supplies to the factories. Moreover, this reduction was contingent on the factories crushing all available cane.

Province.	1939-40	1938-39.	1937-38.
United Provinces	70	69	68
Bihar	32	32	33
Punjab and Sind	3	3	3
Madras	10	7	8
Bombay	8	7	7
Bengal and Assam	9	8	6
Orissa	2	2	2
Indian States	11	11	9
Total	145	139	136

Out of a total of 158 factories existing in India, 145 factories worked in 1939-40. The preceding Table shows the provincial distribution for this and the preceding two years.

Crushing Season.— Six factories started crushing during October, about 60 during November, and some 70 during December, while five factories commenced operations as late as the end of January. Most of the U.P. factories were at work by the end of November, but in Bihar most of the factories started at the beginning of December. Only six factories had closed by the middle of March, compared with 106 in the previous season, and most of the factories ran till the second week in April or later, some 30 continuing in fact till the latter half of May. Grinding days for all India averaged 129 (as against 83 in 1938-39), the maximum being 203 (against 184) and the minimum 30 (against 15). Five factories ground for 180 days or over, 25 for 150 to 179 days, and 90 for from 110 to 149 days.

Capacity of Factories.— Figures for average capacity of factories, expressed in terms of the total quantity of cane crushed in 1939-40 and the two previous seasons are, for all India, summarized in the following Table :—

	1939-40 Tons Cane	1938-39 Tons Cane	1937-38 Tons Cane
Maximum per factory	296,600	288,300	263,100
Minimum per factory	520	810	1,300
Mean per factory	90,600	50,700	72,900

1 ARTHUR H. ROSENFELD. "The Cultivation of Sugar Cane in Peru." *I.S.J.*, 1926, pp. 590-597.

2 Abridged from an article in the *Indian Trade Journal* (October 3rd, 1940) prepared by Mr. R. C. SRIVASTAVA, Director of Imperial Institute of Sugar Technology, Cawnpore.

The average daily crushing capacity for all factories was :—

	1939-40 Tons Cane	1938-39 Tons Cane	1937-38 Tons Cane
Maximum per factory ..	1,960 ..	1,850 ..	2,000
Minimum per factory ..	20 ..	50 ..	35
Mean per factory	710 ..	630 ..	660

In the two principal areas, a U.P. factory had a maximum of 273,700 tons of cane for the season and a Bihar factory 232,500 tons. In daily crushing, a U.P. factory averaged 1,960 tons and a Bihar factory 1,400 tons, these being the highest daily outputs in India.

Sugar Production. -The production of sugar direct from cane in India totalled 1,241,700 tons in 1939-40, as against 650,800 tons in 1938-39 and 930,700 tons in 1937-38. This is the record production for the Indian sugar industry, the previous best having been 1,111,400 tons in 1936-37. Production increased in all the provinces, but the most outstanding increases were in U.P., Bihar and Bengal. In the first two it doubled itself, while in Bengal the increase was fourfold (39,700 tons against 9,900). The details of the season for all India compared with the previous two years are given in the next table :—

TOTAL PRODUCTION OF SUGAR AND MOLASSES BY FACTORIES IN INDIA.

	1939-40.	1938-39.	1937-38.
Factories working....	145	139	136
Cane crushed, tons ..	13,131,700	7,004,800	9,916,400
Sugar, tons..........	1,241,700	650,800	930,700
Molasses, tons	485,300	242,300	349,600
Sugar per cent. cane..	9·45	9·29	9·38
Molasses per cent. cane	3·69	3·46	3·52

The production of sugar and molasses in Burma is shown in the following table :—

Particulars.		1939-40.	1938-39.
Factories working	....	3	2
Cane crushed	Tons (est.)	265,000	220,100
Sugar produced	Tons (est.)	27,700	21,800
Molasses produced	Tons (est.)	9,300	7,400
Sugar per cent. cane	....	10·4	9·90
Molasses per cent. cane	....	3·5	3·36

The highest recovery in India for 1939-40 was 12·31, as against 12·25 in 1938-39. The average recovery for all India was 9·45 (as against 9·29 in 1938-39), with 9·37 in U.P., 9·29 in Bihar, and 9·88 in the other provinces. Seven factories (all in "other" provinces) had recoveries of 11 and higher ; 18 had 10·0 to 10·4, 36 had 9·5 to 9·9, while 43 had 9·0 to 9·4 and 22 had 8·5 to 8·9. The following table gives the average recoveries for the past four seasons :—

AVERAGE RECOVERIES OF SUGAR FROM CANE.

	1936-37.	1937-38.	1938-39.	1939-40.
United Provinces ..	9·65 ..	9·18 ..	9·14 ..	9·37
Bihar	9·20 ..	9·58 ..	9·00 ..	9·29
Other Provinces....	9·60 ..	9·77 ..	9·91 ..	9·88
All-India	9·50 ..	9·38 ..	9·29 ..	9·45

In the last table are given all-India figures for sugar production for the past ten years. For comparison, figures for recovery of sugar in Java have been included.

PRODUCTION OF SUGAR DIRECTLY FROM CANE IN MODERN FACTORIES IN INDIA, 1930-31 TO 1939-40.

Season	No of Factories producing Sugar direct from Cane.	Cane Crushed. Tons.	Sugar Produced Tons.	Percentage —Recovery— for India.	for Java.
1930-31 ..	29	1,317,248 .	119,859 ..	9·09 ..	11·36
1931-32 ..	32 .	1,783,499 .	158,581 ..	8·89 ..	10·46
1932-33 ..	57 ..	3,350,231 .	290,177 ..	8·66 ..	11·16
1933-34 ..	112 ..	5,157,373 ..	453,965 ..	8·80 ..	12·64
1934-35 ..	130 ..	6,672,030 ..	578,115 ..	8·66 ..	12·35
1935-36 .	137 ..	10,033,000 ..	932,100 ..	9·29 ..	13·21
1936-37 ..	137 ..	11,687,200 ..	1,111,400 ..	9·50 ..	11·72
1937-38 ..	136 ..	9,916,400 ..	930,700 ..	9·38 ..	11·40
1938-39 ..	139 ..	7,004,800 ..	650,800 ..	9·29 ..	—
1939-40 .	145 ..	13,131,700 ..	1,241,700 ..	9·45 ..	—

Conclusion. -The toughest problem facing the Indian sugar industry at the present moment, according to Mr. SRIVASTAVA, is that of disposal of surplus stocks. The industry holds large stocks of sugar, manufactured from cane purchased at very high prices. The basic minimum prices originally fixed by the Indian Sugar Syndicate for this sugar generally exceeded Rs. 12 per maund, although the price of cane at the time corresponded, according to the sliding scale, to a price of under Rs. 11 for sugar. It became apparent in due course that such high prices could not be maintained in a season of overproduction. It is reported that unauthorised sales at rates well below the basic prices were not infrequent. Eventually, in July, the Syndicate decided to reduce prices by as much as Rs. 2-8-0 per maund.

The Governments of the United Provinces and Bihar recently withdrew recognition from the Syndicate as it had failed to maintain reasonable prices for sugar. Thereupon factories in the two provinces ceased to be under compulsion to remain members of the Syndicate. The Governments have, however, now restored recognition to the Syndicate and have further agreed to assist the industry to reduce its stocks and to stabilize sugar prices, subject to certain conditions. These are that the Indian Sugar Syndicate will convert itself into an organization for the sole purpose of selling sugar. The Governments will fix the limits of prices and selling quotas. The Syndicate will fix the selling quotas and basic prices of individual factories, within the limits prescribed by the Governments. The Syndicate's executive officer will be nominated by the Governments. A Commission, consisting of officials who will be *ex-officio* Directors of the Syndicate, will be set up by the Governments to exercise control over the industry, but the Syndicate will have the right of direct approach to the Governments. The Government's terms have been accepted by an extraordinary general meeting of the Syndicate.

Bauxite as a Refining Adsorbent.[1]

By W. A. La LANDE, Jr.

[*This article shows that bauxite can be thermally activated to produce a highly efficient adsorbent for refining syrups and liquors. This activation is done simply by heating to* 600—900°*F.* (316 *to* 483°*C.*). *Activated bauxite has a considerable capacity for removing colour and ash, and it is also shown here to have the power to remove invert sugar from solution as well. It can be regenerated repeatedly while maintaining its high efficiency. These experiments supplement those already described by* F. HARDY.[2] *Reference is made to U.S. Patent No.* 2,211,727.[3]— ED.].

The primary object of these experiments was to determine the sugar refining characteristics of bauxite by a series of regulated and reproducible tests. No attempt was made to simulate plant operating conditions precisely.

All the data are based on experiments made with a thermally activated Arkansas bauxite in the form of 10 to 30 mesh granules, with a settled volume weight of 57·5 to 58·0 lbs. per cubic foot. The absorbent was light tan in the natural state and became slightly darker as a result of activation.

For the purpose of making comparisons, first-quality service bonechar, sugar liquors and syrups were obtained from a large refinery, and processed as soon as received.

Brix before filtration; the high-purity liquors were run at 60° Brix. In the work with the large filters only 60° Brix solutions were processed.

The temperature during percolation was usually maintained at 165°F. (74°C.). Arbitrarily, the small filters were run at 5 c.c. per min. (after a "shut-in" period of 20 min. immediately following the beginning of filtration) until 900 c.c. of filtrate were collected. The large filters required about 30 min. to "show through" after which they were shut in for 4 hours and then run at 12 c.c. per min. until 2·0 to 2·5 lbs. of solids per lb. of adsorbent had passed through.

The used adsorbents were regenerated by thorough washing with hot water until the solids content of the washings became negligible, drying, and heating at 700 to 850°F. (372 to 454°C.) in air (gas-fired rotary furnaces) for 0·5 hour. The cooled product was then screened to remove fines and charged to the filter.

TABLE 1. REFINING EFFICIENCY *vs.* ACTIVATION TEMPERATURE.

Dry Basis.	Unfiltered Wash Syrup.	Filtrate Composition at Bauxite Activation Temperature of: 500°F.	600°F.	700°F.	800°F.	900°F.	1000°F.	1100°F.
Polarization, per cent.	75·07	81·72	85·75	85·65	84·49	84·14	83·06	81·65
Invert sugar, per cent.	10·57	9·25	7·98	8·25	8·49	8·86	9·15	9·20
Ash, per cent.	6·90	4·03	2·56	2·79	3·06	3·10	3·52	3·65
Undetermined, per cent.	7·46	5·00	3·71	3·31	3·96	3·90	4·27	5·50
Colour, per cent.	18·70	8·90	2·50	2·80	2·90	2·90	2·90	2·90
pH	6·40	6·80	6·90	6·80	6·70	6·50	6·20	6·10
Polarization increase	—	6·70	10·70	10·60	9·40	9·10	8·00	6·60
Invert sugar, per cent. decrease	—	12·50	24·60	22·00	19·70	16·20	15·50	15·00
Ash	—	41·60	62·60	59·60	55·60	55·20	47·90	47·10
Colour removed, per cent.	—	52·40	86·60	83·40	84·50	84·50	83·40	83·40

The filtrates from the bauxite and char filters were tested for iron by both the ferrocyanide and sulphide methods. Usually the tests were negative or indicative of a negligible trace of iron. In all cases where the tests were interpreted as positive, the char filtrates showed more iron than the solutions from bauxite.

Operating Technique.—Two sizes of steel filters were used, the smaller tubes being 1·5 in. diam. and 18 in. long, and the larger 4 in. diam. and 40 in. long. They were surrounded by agitated water-baths maintained at the desired temperature (±2°F.).

The smaller filters were charged with 300 grms. of bauxite (equal volume of char) per tube, while the larger ones required about 7,300 grms. (16 lbs.) of bauxite. They were charged by gravity from a supply tank. For the experiments with the small tubes, the low-purity syrups were diluted to 30°

BAUXITE ACTIVATION TEMPERATURE.

In these experiments the filters were run at 5 c.c. per min. to equal volumes of filtrates. The filtration temperature was 165°F. (74°C.). The progressive dehydration of the type of bauxite used in this work was observed by heating portions of 10 to 30 mesh raw bauxite in a gas-fired rotary kiln until the total volatile matter content of the material became practically constant. The results with a wash syrup (Table I) showed that the optimum refining efficiency is obtained by activating the bauxite in the range 600 to 900°F. (316 to 483°C.).

[1] *Ind. & Eng. Chem.*, 1941, 33, pp. 108-111 (here somewhat abridged). [2] *I.S.J.*, 1938, pp. 64-68. [3] *I.S.J.*, 1941, p. 97.

Using the group of data obtained for this range as a standard for comparison, it was apparent that by heating at temperatures high enough to effect substantially complete dehydration of the bauxite, the filtrate *pH* was decreased, the polarization was decreased, and the ash and invert contents of the product were higher.

When the adsorbent was heated at temperatures below about 600°F., i.e., where the resulting water content of the product exceeds approximately 10 per cent., the colour removal efficiency was sharply decreased (52·4 per cent. at 500°F. compared with an average of 85 per cent. in the range 600 to 900°F.) the polarization was lower, and the ash and invert contents of the products were higher. The filtrate *pH* obtained from an adsorbent activated at 500°F. compared favourably with the *pH* produced by the 600 to 900°F. activation.

TABLE II.

FILTRATION TEMPERATURE.

Dry Basis.	Unfiltered Wash Syrup.	Filtrate at Temperature of (in °F.) :— 127°	145°	163°	181°	199°
Polarization %	84·64	88·97	88 72	88·61	89·34	88·10
Invert sugar %	6·27	5·85	5·83	5·80	5·72	5·52
Ash %	3·00	1·83	1·66	1·59	2·09	1·75
Undetermined %	6 09	3·35	3·79	4·00	2·85	4·65
Colour %	50·90	4·50	2·70	2·50	3·00	3·40
pH	6·60	6·60	6·60	6·60	6·40	6·20
Pol. increase....	--	4·50	4·10	4·00	4·70	3·50
Invert sugar % decrease	—	6 70	7·00	7·40	8·70	12·20
Ash	—	38 90	44·60	46·90	30·30	41·70
Colour removed %	—	91·10	94·70	95·10	94·10	93·30

Similar trends were noted in the experiments with high-purity sugar liquor. The average decrease in invert sugar was 52 per cent. in the activation range 600 to 900°F., approximately the same at 500° but only 24·6 per cent. at 300°, 33·4 at 1000° and 20·8 at 1400°F. This increase in the invert content of the filtrates follows the decrease in the *pH* of the solutions with rising temperature of activation. Within the 600 to 900°F. range the filtrate *pH* is equal to the charge *pH*, but above 900° the *pH* becomes progressively lower until at 1400° it is 1·3 units below the *pH* of the starting material.

Obviously, high-purity liquors are more sensitive than sugar syrups to this tendency of high temperature activated bauxite to produce filtrates of low *pH*. Except for the product activated at 300°F., all the adsorbents accomplished about the same degree of ash removal.

OPTIMUM FILTRATION TEMPERATURE.

To determine the effect of filtration temperature on refining efficiency, experiments similar to those already described were repeated at 127, 145, 163, 181 and 199°F., with 10 to 30 mesh bauxite which had been calcined at 800°F. The results in Table II show that the polarization and the invert adsorption varied only slightly with filtration temperature. The ash removal efficiency was highest at 163°F., and the colour removal increases as the temperature rises to 163°F. decreasing thereafter as the percolation temperature was raised. The filtrate *pH* was constant in the range 127 to 163°F. but decreased progressively at the higher temperatures. Similar results have been obtained with solutions of higher and lower purity than the syrup used. A temperature of approximately 165°F. (74°C.) is recommended for the activated bauxite refining of sugar solutions.

REGENERATION OF USED BAUXITE.

Various solutions and combinations of solutions were successfully charged to a 16 lb. activated bauxite filter, with regeneration of the adsorbent by thorough washing and calcining in air at 700 to 900°F. for 0·5 hour after each of the seven filtration cycles. No make-up was added to the bauxite. The experiment included four runs with low-purity solutions, two with barrel syrup, and two with wash syrup.

The greatest difference between the adsorbents lay in the ash-removal effectiveness, the results of this experiment indicating a decrease of about 12 per cent. in the efficiency of the regenerated adsorbent. The difference between the new and regenerated adsorbents in their effect on polarization and on invert removal was small and probably negligible;

TABLE III. COMPARISON OF ACTIVATED BAUXITE AND BONECHAR.

Dry Basis.	Filtrate Composition. Unfiltered Wash Syrup.	Activated bauxite.	Bonechar.	Unfiltered Wash syrup.	Activated bauxite.	Bonechar.	Unfiltered liquor.	Activated bauxite.	Bonechar.
Polarization, per cent.	75·87	81·27	77·42	83·68	87 76	85·78	97·83	99·07	98·77
Invert sugar, per cent.	10·39	9·04	10·30	5·30	4·62	4·84	0·54	0·36	0·47
Ash, per cent.	6·83	3·93	5·68	4·13	2·70	3·42	0·20	0·03	0·12
Undetermined, per cent.	6·91	5·76	6·60	6·89	4·92	5·96	1·43	0·55	0·64
Colour, per cent.	29·30	5·50	6·10	19·30	4·00	4·00	82·00	2·50	2·80
pH	6·30	6·60	6·50	7·00	6·70	6·70	6·70	6·40	7·10
Polarization increase	—	5·40	1·60	—	4·10	2·10	—	1·24	0·90
Invert sugar, per cent. decrease	—	13·00	3·38	—	13·00	8·80	—	32·80	11·90
Ash	—	42·50	16 90	--	34·70	17·10	—	87·00	38·50
Undetermined	—	16 60	4·30	—	28·00	13·40	—	62·00	55·20
Colour removed, per cent.	—	81·20	79·20	—	79·30	79·30	—	97·00	96·60

the composite colour of the filtrate from new bauxite was slightly superior to that of the regenerated bauxite, but the percentage colour removal by the two refining agents was almost identical.

Comparison of Activated Bauxite and Bonechar.

The analytical data in Table III are representative of the relative merits of bauxite and bonechar under identical and rigorously controlled experimental conditions, and are typical of a large number of experiments designed to compare the two adsorbents under various operating conditions.

On both washed liquors and wash syrups activated bauxite was superior to bonechar in increasing the polarization and in decreasing the ash and invert contents of the solutions. The difference in ash removal effect was especially striking, the decrease in ash content produced by activated bauxite being at least twice that accomplished by char. The colour removal efficiencies of the two adsorbents were approximately equivalent. The bauxite filtrates from solutions of intermediate and low purity were rich amber in colour and yielded exceptionally high-grade soft sugars. The filtrates from bonechar tended to show a higher *pH* than those from bauxite. The difference was small with low purity solutions and in some cases is in favour of the latter adsorbent, but with sugar liquors bauxite invariably produces the lower *pH*.

Improving the Work of the Filter-Press.[1]

By J. L. SALVADOR.

Filter-press operation in sugar factories in Cuba has deteriorated in recent years, due to working at excessive pressure without any material improvement in the quality of the press-cakes. Some mills have gone to the extreme of discharging in a semi-liquid or pasty condition. This state of affairs is to be attributed to the decreased amount of *bagacillo* in the mixed juices as the result of using cloths in the mill strainers, a practice which has been established with the object of reducing the insoluble content of the sugars made.

In one of the Cuban factories, a plant was installed which was capable of collecting 2 lbs. of fine *bagacillo* per minute, sufficient for a daily grinding capacity of 75,000 arrobas (say 1,000 short tons), the particles of which should pass a No. 16 mesh screen placed in the bagasse conveyor. After collecting, the *bagacillo* was sent by suction to the mud tank in amount depending on the nature of the muds to be filtered.

Two independent feeding pumps were used for each filter with their corresponding piping. One was applied only at the beginning of the charging process at a pressure not exceeding 15 lbs. with the object of forming the cake. As soon as the initial rate of filtration decreased, the operator connected the other or pressure pump to obtain an average pressure of 60 lbs. This was continued until the filter-press no longer gave out an appreciable amount of liquid. Before the liquid blew came to an end, the pressure was stopped, and the operator proceeded as follows :

A hot water connexion was fixed to each filter in order to wash the cake until the issuing juice was reduced to 8 to 10° Brix, or less. As soon as this happened, air was applied to the filter-press to dry the cake and expel liquid particles. It was applied at a pressure of 70 to 75 lbs., the diameters of the water and air pipings being 2 in. and 1½ in. respectively. It was found on discharging the filter that the cake was compact, dry, and easy to release, leaving the cloth absolutely clean.

In some mills an additional 1 in. pipe for direct steam was installed, so that when again closing up the press any wax deposits accumulating in the cloths could be melted off. This resulted in a better filtration, enabling the cloths to be used for a longer period of time without washing. One of the main advantages resulting from this method is that the presses can be worked in rotation, some being charged, whilst others are filtering, drying or discharging.

As the result of applying the above described method, a 20 per cent. increase in capacity has been obtained. Excessive liming of the muddy juices was not required, the *pH* of the filtered juice being made to average 7·6. It is unnecessary to add that in order to achieve this result, frames and plates, with all groovings, linings and holes, should be properly ground and in good working order.

Canadian Consumption of Sugar during 1940.—Consumption of refined sugar in Canada during 1940 totalled 500,943 long tons (according to Lamborn), as against 509,716 tons in 1939. Of this amount approximately 75,000 tons or 15 per cent. were beet sugars produced in the Dominion, while the remainder was derived from imported cane sugars coming chiefly from the Empire.

1 *Proceedings of the 13th Annual Conference of the Association of Sugar Technologists of Cuba* pp. 61-62 (here abridged).

Clarification with Upward Sludge Filtration.[1]

By J. ADALBERTO ROIG.

The new POJ type canes and other varieties have brought about various methods of pre-treatment of the raw juices such as sulphitation, fractional liming, etc. All of these have been helpful, but in the search for better clarification, it seems that heretofore the most important factor has been overlooked—that of providing a properly designed clarifier for the mechanical separation of the visible solid matter and the invisible colloidal impurities from the pre-treated juices.

If an inefficient mechanical clarifier is used for the separation of the floc, formed from the juices by pre-treatment, all the painstaking work put into the preliminary process will be wasted. Floc once formed must be handled very carefully or it will be re-dispersed, and cannot be removed by ordinary precipitation. Let us, therefore, determine why clarification up to the present has not been completely satisfactory.

Many years have been devoted to experimenting on the mechanical separation of solids from liquid. This work has proved that any problem of clarification can be divided into three definite operations: (1) coagulation of the suspended solids to a point where the floc particles become sufficiently large to settle; (2) settling of the formed floc in chambers which are free from counter and convection currents; and (3) filtering of the liquid for the removal of non-settling particles and colloidal matter.

The coagulation operation is an important one in a mechanical clarifier, since here the work done during pre-treatment can either be developed or destroyed. During pre-treatment a very finely divided floc is formed which must be agglomerated or combined in a suitable coagulation chamber to form larger particles of sufficient weight to settle.

The coagulation chamber of the mechanical clarifier must therefore be designed to provide slow and gentle agitation of the pre-treated juices, in order that the particles of finely divided floc in the pre-treated juices will be agglomerated or brought together to form floc of sufficient weight to settle to the bottom of the clarifier. Movement of the juices must of necessity be gentle. Violent stirring would break up the delicate structure of the floc formed in the pre-treatment, in which event settling would not take place. It follows that the juices must be delivered at exceedingly low velocities to the various settling chambers. This is why continuous clarification up to the present has failed to produce entirely satisfactory results, not only with sugar juices, but also with water for municipal supply, etc.

On studying the design of some of the continuous clarifiers used in the sugar industry, we find a very elaborate coagulation chamber, but then in its operation all of the good work done in agglomerating the floc is broken up by passing the coagulated juices through a restricted channel to the settling chambers at high velocities, thus breaking up the carefully prepared floc. To prevent this action the channel must be sufficiently large to reduce flow velocities below 50 ft. per hour.

Further, the design of the various settling chambers is of utmost importance. They should eliminate counter and convection currents. The flow of liquid to them should be uniform and at low velocity to prevent short circuiting and the holding of floc in suspension. Settling can only take place when the velocity of the liquid is reduced below the point where re-suspension takes place, viz., 50 ft. per hour or over. Therefore, much lower entrance velocities to the chambers are advantageous, viz., approximately 12 to 15 ft. per hour.

Good settling alone, however, does not provide good clarification, especially in raw sugar juices from the new varieties of cane, which, in addition to heavy suspended matter, also contain light particles of cane fibre, or *bagacillo*, and colloidal impurities which do not settle. It is, therefore, essential that some means be embodied in the clarifier for filtering out this matter during the settling operation.

It should be designed to utilize the flocculated material (so-called sludge) which has been settled from the juices, and is deposited on the top of the settling chambers as a filtering medium.

A study of any settling problem will demonstrate that the materials settling from a liquid will stratify. The heavier particles will come to rest first and the lighter particles will stay in partial suspension according to their specific gravities. It will also be noticed that there is a definite point of separation of the cloudy and clear juice. It is the material below the line of separation which can be utilized as a filtering medium through which the raw juices can be passed upward for the removal of the non-settling and colloidal impurities. Here again high velocities of flow must be guarded against, to prevent carry-over and the breaking up of the filter-bed.

Realization of the fact that non-settling materials and colloidal impurities were not completely removed by ordinary methods of precipitation led to the development of a continuous clarifier embodying the principle of Upward Sludge Filtration.[2]

In the design of this apparatus consideration was given to the three definite operations mentioned in a foregoing paragraph, and in addition it is intended to remove as much as possible the guesswork as to what goes on inside of the unit. Various important

[1] *Proc. 13th Conf. Assoc. Cane Sugar Tech. Cuba*, pp. 281-284. [2] *I.S.J.*, 1940, p. 102.

controls are embodied in its design by the use of which the operator can definitely control the clarity of the juices and the concentration of the muds.

The design of the unit is simple. The outer shell is a vertical cylindrical tank of steel plate which varies in height to accommodate one, two, or as many as five bell-shaped settling chambers. The raw pre-treated juices after heating are delivered to a flash tank mounted on top of the clarifier for the removal of flash steam which develops with the drop in temperature and pressure. From the flash tank the juices flow by gravity into the upper part of the clarifier known as the coagulation chamber. Here the pre-treated juices are kept in gentle motion for the agglomeration of floc particles before being delivered to the peripheral feed channel for distribution to the settling chambers.

The peripheral feed channel is the annular space between the outer shell of the tank and the aprons of the bell-shaped settling chambers and it is built very large. This large feed channel area reduces the flow velocity of the juices below the maximum allowable of 50 ft. per hour, thus eliminating the possibility of re-dispersion of the delicately formed floc. The heavy solids which the juices contain settle directly to the conical bottom of the clarifier for removal; while the lighter materials, with the juices to be clarified, enter the bell-shaped settling chambers through annular openings or weirs formed by the skirt of the upper chamber and the top of the chamber below.

The muds which settle from the juices are deposited on the top of the settling chambers forming a stratified layer of sludge varying in density according to its specific gravity. The incoming juices entering the settling chambers are filtered upward through this layer of sludge, and in this way the fine non-settling and colloidal impurities are entrapped and removed with the muds. The concentrated mud which forms on the top of the settling chambers is propelled by means of a scraper system into the peripheral feed channel. This counter-flow of concentrated mud through the annular openings or weirs provides a screen of mud parallel to the tray apron plates through which the incoming juices must also pass before entering the various settling chambers; thus the juices are given a double filtering, or screening, in addition to natural settling before being discharged from any of the settling chambers as clear liquor.

The clarified juices are withdrawn at the centre of each settling chamber, which point is far removed from the inlet and is free from any disturbance by eddy and convection currents. The rate of clear juice discharge from any settling chamber can be varied by the operator by means of an adjustable outlet in the totally enclosed draw-off box.

Control and removal of sludge and mud accumulated on the tops of the settling chambers is accomplished by the scraper system, which propels the concentrated muds radially into the peripheral feed channel. Each settling chamber is provided with an adjustable sample tester whereby the depth of the sludge bed on the tops of the settling chambers can be definitely determined by the operator. If the sludge bed is higher or lower than desirable it simply becomes a question of increasing or decreasing the speed of the scraper system to vary the rate of mud removal.

Upward Sludge Filtration is an exclusive feature of the Graver Clarifier, and numerous installations are proving that through its use operating efficiencies can be greatly increased and a higher quality raw and refined sugar can be produced. We installed one of these clarifiers in our mill during the 1938 grinding season, and found that it consistently produced a sparkling clear juice from which a raw sugar of high filtrability was made, even though we had increased our grinding rate over 3,000 tons per 24 hours, which is the rated capacity of our clarifier. Bearing in mind that the cane we grind contains at times more than 6 to 8 per cent. of mud on cane, we found that even with this excessive amount of mud the clarifier handled the juices exceedingly well and the concentrated muds were easy to filter.

The *pH* factor and losses by inversion of sugar were reduced to a minimum. Tests showed that the maximum drop in *pH* between incoming juices and juices extracted from the mud was only 0·42 *pH*. This was due to the very careful method of handling the coagulated materials in the juices, which also accounts for the excellent concentration of mud drawn from the bottom where concentrations of solids up to 25 per cent. are common. We feel that Upward Sludge Filtration has many advantages over the older methods of clarification and that by its use operating costs are reduced considerably.

ANTIGUA'S 1941 CROP.—At the start of the current sugar crop in Antigua, B.W.I., estimates were for a production of some 24,000 tons, instead of the 40,000 tons at one time expected. Drought conditions during the latter half of 1940 affected the crop most adversely.

JAVA 1940-41 CROP.—According to Willett & Gray, estimates of the Java sugar crop of 1940 (May to December), made when the bulk of the mills had closed down, put the total at about 1,602,000 metric tons. This will involve a considerable carry-over, it is thought. Results during the year were excellent and some mills had record returns. For the 1941 crop plantings are larger and the outturn will be bigger unless a spell of exceptionally dry weather that was experienced proves to have had a detrimental effect on the yield. The question of plantings for the 1942 crop has lately come up for decision, and presents unusual difficulties. If the war continues a much smaller crop will suffice, but if on the other hand peace should be established before the crop is due to be harvested in 1942, a normal crop may be needed, as the countries which formerly used to draw supplies from Java will then need all the sugar they can get and pay for, to replenish stocks.

Chemical Reports and Laboratory Methods.

Expressing the Results of a Chemical Analysis of Water. Editorial. *The Betz Indicator*, 1940, **9**, No. 3.

There are in the main two general methods of reporting water analyses, these being : (1) the ionic form, and (2) the hypothetical combination. In the former each element or radicle is reported individually, e.g., Ca, Mg, CO_2, SO_4, etc. ; while in the latter each of the elements or groups are hypothetically combined. Thus the calcium becomes so much calcium bicarbonate, calcium carbonate, or calcium sulphate.

These combinations are made on purely theoretical grounds, based on the relative solubilities of the probable composition of the salts present in the water, but, because of the uncertainty of the assumptions made, the ionic form of reporting is gradually being adopted by all modern chemical laboratories. It eliminates guesswork as to how the elements might be combined in the water, and eliminates misunderstanding between analysts on the interpretation of the figures.

Then there is another difference in the manner of reporting the results of water analyses, namely that some may report in parts per million, some in grains per gallon, and others in parts per hundred thousand. Lack of uniformity in reporting these analyses is irrational and liable to give rise to misunderstanding.

Analysis No. 1.

	p.p.m	e p.m.
Total Dissolved Solids (determined)	130 0	
Calcium as Ca	34·0	1·700
Magnesium as Mg	1·9	0·156
Sodium and Potassium	—	0·387
Sodium and Potassium as Na	6·8	—
Bicarbonate as HCO_3	79·0	1·300
Sulphate as SO_4	34·0	0·710
Chloride as Cl	5·2	0·146
Iron as Fe (ferrous)	2·7	0·097
Silicate as SiO_2	7·0	0·184
Nitrate as NO_3	0·0	0·000
Total Hardness as $CaCO_3$	93·0	1·856

Analysis No. 2.

	g.p.g.
Ferrous Bicarbonate	0·5
Calcium Bicarbonate	5·6
Calcium Sulphate	1·9
Magnesium Silicate	0·5
Sodium Silicate	0·1
Sodium Sulphate	0·9
Sodium Chloride	0·5
Total Hypothetical Solids	10·0

In the U.S.A. the use of the ionic form of reporting in p.p.m. is standard with such bodies and authorities as : Government departments, the American Water Works Association, and the American Society for Testing Materials.

Recently, however, the last-named body has called for all reports to be rendered in the ionic form, and in addition to stating p.p.m. also to give the e.p.m., that is, the "equivalents per million." This latter is obtained by dividing the p.p.m. by its combining weight calculated from its molecular weight and valency. E.p.m. are added with the idea of eliminating the necessity of expressing results in the form of hypothetical combinations.

Use of e.p.m. is particularly useful in expressing the results of hardness and alkalinity, where the determination in each instance is made for a group of similarly acting ions, and also in figuring required dosages in the lime-soda softening process. Herewith are given analyses of the same water (of Washington, D.C.), No. 1 showing the ionic form in p.p.m., and No. 2 that including the hypothetical combination of the constituents in grains per gallon.

American Apparatus and Instruments. Ralph H Muller.[1] *Ind & Eng. Chem.* (analy. ed'n.), 1940, **12**, pp 571-630.

From the immense amount of information given, one can cull the following notes : In the latest design of the Ainsworth analytical balance the full resources of "instrumentation" are utilized. It embodies the latest refinements of balance construction with the convenience of a keyboard-operated weight carrier, handling all fractional weights up to and including 1 grm.

Bimetallic dial thermometers for general industrial use are finding increased applications, now having an accuracy within 1 per cent. of the range over the entire scale. Rotameters have been greatly simplified by the development of a new float design rendering flow readings independent of viscosity.

A precision refractometer, retaining the ease and simplicity of the Abbe type, has been evolved by careful attention to the elimination of bearing errors, securing quick temperature regulation, and by eliminating compensator error due to the use of a monochromatic light source, instead of the customary Amici prism. It gives readings reproducible to 0·00003. Its equivalent is available as a precision sugar refractometer.

In the case of a number of materials, a true colour specification is of little interest, and it is merely necessary to compare samples with a standard of the same nature to see if they possess the same shade. Such measurements are valuable on white sugar, and instruments have been designed which enable one to measure the reflecting power of the sample as related to a standard sample.

[1] New York University, N.Y.

In the Leitz glass electrode type of *pH* meter, the design is based on the Poggendorf voltage compensation method, but the potentiometric balance is secured electronically without the use of any moving parts. It is calibrated against a single buffer in one operation, after which the *pH* of any solution can be read directly on the meter. An ambient temperature compensator is provided.

Under the heading of general appliances, mention is made of the Barnstead laboratory water still, which is fully automatic, self-starting, self-stopping and flushing, and will operate entirely without attendance. It is stopped and started automatically, controlled by the distilled water level in the storage tank, and the evaporator is automatically drained and flushed of sediment at regular intervals.

Under the heading of gadgets are mentioned the "Desicooler," a spun aluminium equivalent of the heavy and breakable glass desiccator; alkacid paper in strips, the equivalent of a universal indicator; and the burette regulator, a very ingenious clamp which permits the automatic positioning of the stopcock in two locations, one for fast and the other for drop-wise delivery.

There is no question that the quality and quantity of work emanating from a laboratory depend to a large extent on the convenience and utility of the general equipment. Great strides have been made in laboratory furniture of all kinds in which utility and pleasing appearance are combined. Use is made of stainless steel and corrosion-free materials extensively.

Clerget Reducing Sugars Ratio as Index of the Fermenting Capacity of Molasses. JOSÉ MARTINEZ DALMAU.[1] *Proceedings of the 13th Conference of the Association of Sugar Technologists of Cuba*, pp. 307-309.

Attention is called by the author to the anomalies to be observed in respect of the quantities of alcohol obtained from molasses of a certain content of total sugars. This is due to the unfermentable reducing sugars present. Actually the alcohol yield can be established by a previous fermentation test, which is hardly convenient as a routine means of assessing the value of the molasses entering the distillery.

So the use of the ratio: $\dfrac{\text{Sucrose by Clerget}}{\text{Reducing Sugars}}$ was considered as a possible index of the fermenting capacity of distillery molasses. Referring to the results of the analysis of 19 samples of molasses (here tabulated), it will be seen in the case of No. 11, for example, that it has 52·5 per cent. of total sugars, that its alcohol yield is 1·62 litres, its fermentation efficiency 90·0, and its ratio of sucrose by Clerget per cent. over reducing sugars per cent. 2·14.

No. 6, on the other hand, contains 58·86 per cent. of total sugars; also yields 1·60 litres of alcohol; has a ratio of 1·8, but a fermentation efficiency of only 84·20. It is evident that the distiller should prefer the first sample to the second, since with 6·36 per cent. less total sugars it yields the same amount of alcohol.

On further referring to the table, it is seen that Nos. 8 and 10, though they have practically the same

No.	Brix.	Weight per gall. kgs.	Sucrose by Clerget per cent.	Reducing Sugars Per cent.	Sucrose by Clerget / Reducing Sugars.	Total Sugars. Per cent.	Fermentable Sugars. Per cent.	Ditto per gall. kgs.	Alcohol possible litres per gall.	Alcohol obtained by fermentation, litres.	Fermentation efficiency.
1	88·60	5·560	36·80	22·30	1·64	59·10	61·05	3·39	2·03	1·66	81·80
2	85·00	5·467	41·13	16·74	2·46	57·87	60·00	3·28	1·96	1·83	93·40
3	86·40	5·503	37·00	25·20	1·46	62·20	64·16	3·52	2·11	1·75	82·90
4	85·60	5·482	40·97	18·97	2·16	59·94	62·11	3·35	2·01	1·75	87·00
5	84·00	5·442	37·98	20·18	1·88	58·16	60·17	3·27	1·96	1·67	85·20
6	83·90	5·438	38·56	20·30	1·80	58·86	69·80	3·30	1·98	1·60	84·20
7	85·60	5·482	36·00	20 40	1·76	56·40	58·30	3·18	1·90	1·61	84·20
8	86·20	5·498	38·55	17·30	2·27	55·85	57·90	3·18	1·90	1·75	90·60
9	81·40	5·375	35·40	19·55	1 50	54·95	56·92	2·95	1·77	1·50	84·90
10	82·60	5·406	35·30	20·35	1·73	55·65	57·52	3·10	1·86	1·53	82·40
11	86·60	5 508	35·80	16·70	2·14	52·50	54·39	3·00	1·80	1·62	90·00
12	85·50	5·480	38·03	19·63	1·94	57·66	59·67	3·26	1·95	1·66	85·10
13	86·00	5·493	36·00	26·10	1·38	62·10	64·00	3·50	2·10	1·70	80·95
14	81·50	5·387	35·31	19·30	1·82	54·61	56·47	3·03	1·81	1·50	83·30
15	82·40	5·400	39·02	20·92	1·86	59·94	61·05	3·39	2·03	1·68	86·55
16	88·40	5·555	36·89	16·67	2·20	53·56	55·51	3·08	1·80	1·60	88·00
17	83·30	5·243	36·75	22·40	1·60	59·15	61·09	3·30	1·98	1·65	83·30
18	82·00	5·390	44·00	16·00	2·75	60·00	62·32	3·35	2·01	1·80	90·00
19	84·10	5·444	40·27	19·43	2·07	59·70	61·83	3·36	2·01	1·84	90·14

Note: Litres of obtainable alcohol equals: Fermentable sugars per gallon, multiplied by 60 and divided by 100; The efficiency of fermentation refers to open containers.

[1] Of the Inland Revenue Division of the Treasury Department, Cuba.

total sugars, have different yields of alcohol, namely 1·75 against 1·53 litres, while the ratios are 2·27 and 1·73 respectively. No. 13 contains 62·10 per cent. of total sugars, yet yields only 1·7 litres out of a possible 2·10; its ratio of 1·38 indicates that its efficiency should not exceed 80. Sample 19, on the other hand, with a ratio of 2·07 yields 1·84 litres out of a possible 2·01, its efficiency thus being 90·14.

Generalizing, it is concluded that it is easy to select from the ratio of sucrose by Clerget to reducing sugars per cent. samples suitable for use in the distillery. When the ratio ranges from 2·00 to 2·50 the fermentation efficiency is 90 per cent.; and when the ratio is between 1·60 and 2·00, it is 85 to 95; but when the ratio is below 1·50 it means the sample is to be rejected as inferior for use in the distillery.

Pulping Bagasse by Chlorination Method. LILLY GOMEZ and GEMINIANO O. AGUILA. *Univ. Philippines Nat. and Applied Sci. Bull.*, **7**, pp. 227-231; through *Chem. Abs.*, 1940, **34**, p. 3081.—Laboratory pulping experiments with bagasse from several sources, in which chlorine gas and a diluted sodium hydroxide solution followed by hypochlorous bleaching are used, gave a 37 per cent. yield of pulp with an α-cellulose content too low (approx. 76·5 per cent.) for satisfactory use for rayon production. Complete analyses of the chemical composition of the bagasse and resulting pulp are given.

Preliminary Experiments with Cement Ingredients. W. R. S. LADELL.[1] *J.A.S.T. Quarterly*, 1940, **3**, pp. 25-41.—One of the minor troubles in Jamaica resulting from the war is the increasing cost and scarcity of cement. An account is given here of preliminary experiments on the possibilities of so-called pozzuolanic cements[2] from locally obtained ingredients. It is known that cements and mortars of a pozzuolanic nature must have been used in Jamaica before Portland cement was discovered, as shown by existing old buildings. None of the materials used in the author's tests (red brick, fire-brick or burnt clay) were found to possess sufficient pozzuolanic propreties to make reliable cements by admixture with lime alone. Trials were therefore made with different proportions of bagasse ash, added to the lime. On mixing with sand, forming into blocks, and soaking the blocks in water for seven hours, all remained hard; but none of them approached in strength similar blocks made of Portland cement.

Bagasse. II. Chemical Properties of the Hot Water and Ammonium Oxalate Extracts of Bagasse. III. Hemicellulose of Bagasse. SUGURU MIYAKE, EIZIRO HAMAGUTI and HUMIWO KURASAWA. *J. Soc. Trop. Agr., Taihoku Imp. Univ.*, **11**, pp. 207-226; through *Chem. Abs.*, 1940, **34**, 6472.—A ppt. was obtained from the hot water extract of bagasse by the addition of 3 vols. of alc. *d*-Galacturonic acid was isolated from the hydrolyzate of the ppt. *d*-Galactose and *l*-arabinose also were found. Bagasse was extracted with hot water and ammonium oxalate, and the residue was again extracted with 4 per cent. NaOH and 8 per cent. NaOH. A kind of hemi-cellulose consisting of 7 to 8 per cent. of arabinose and 92 to 93 per cent. of xylose, and another containing xylose, arabinose and glucose were isolated.

A System of Chemical Control (based on the Direct Fibre Determination). ARTURO DE MENA Y VAILLANT. *Proc. 13th Conf. Assoc. Cane Sugar Tech. Cuba*, pp. 249-252. Particulars are given of a system of chemical control based on the direct determination of the fibre per cent. cane and on juice analyses. It does not require juice or bagasse weights, nor the weight or volume of imbibition water, all of which are directly calculated from the weight of cane ground, which latter figure must be accurately obtained. An initial determination of the residual juice in the bagasse should be made.

Action of Alkali, Salts and Organic Solvents on *d*-glucose. J. DUBOURG and R. SAUNIER. *J. Fabr. Sucre*, **78**, pp. 504-507: through *Chem. Abs.*, 1940, **34**, 3526.—Investigation of the change in the rotary power of *d*-glucose with time under the influence of alkalis indicated that the destruction of the glucose by the alkali is preceded by the formation of an alkali salt of glucose (as with sucrose), since a slow decrease in rotary power accompanied by the development of a brown colour is followed by rapid and considerable decrease in this property. Ammonia effects the destruction of the *d*-glucose although without previous salt formation (slight reduction in rotation). Alcohol, like other organic solvents (methyl alcohol, acetone, etc.), increases the rotary power of *d*-glucose in neutral solution by displacing the equilibrium of the *a* and *b* forms of the *d*-glucose in favour of the former as the result of dehydration. Likewise, a sharp reduction in the degree of rotation of an alkali solution of *d*-glucose takes place in the presence of alcohol as a result of the dehydrating action. Destruction of the alkali salt of glucose, however, is retarded by alcohol. The addition of ammonia and alcohol reduces the degree of rotation as a result of the marked decomposing action of the ammonia on the glucose. Neutral salts serve to make the reduction in rotary power in alkaline solution more marked; they produce a slight increase in the degree of rotation in neutral and acid solution; and even increase the degree of rotation in an alcohol solution of *d*-glucose.

1 West Indies Sugar Co. Ltd.

2 Pozzuolanic ingredients are "materials which though not cementitious in themselves contain constituents which will combine with lime at ordinary temperatures in the presence of water to form stable, insoluble compounds possessing cementing properties." The word is derived from the name of a town near Naples, Pozzuoli, the volcanic ash in the neighbourhood of which mixed with ordinary lime forms a hydraulic cement.

Beet Factory Technical Notes.

Nyssa Beet Sugar Factory : Further Details. R. H. COTTRELL. *Facts about Sugar*, 1940, **35**, No. 9, pp. 22-25.

Particulars have already been given of the Amalgamated Sugar Co.'s new factory at Nyssa, Oregon, U.S.A.[1] and now information is given of its second campaign, which was completed on January 25th this year. Sugar made was 720,000 bags of 100 lbs. each, and the plant sliced about 2,374 tons per day, at times rising to 2,488 tons. As much as 15 tons of beets to the acre were averaged in this district. Some changes and additions to the plant indicate a probable production next campaign of one million bags; that will be an increase of nearly 66 per cent. over the original rating of the factory.

A new feature introduced is the Bemning single tank, using the Dorr continuous carbonatation process, which has proved very satisfactory. Another is a special type of counter-flow juice heaters built by the Ogden Iron Works, which raises the temperature of the outgoing juice to within 1°C. of the temperature of the heating vapour. Then the beet lift equipment is something new. It raises beets and flume water 9½ ft. to the level of the washer room, and consists of a large, slow-running centrifugal pump capable of passing any object up to 18 in. in diam. and of pumping up to 4,500 gallons per minute.

Diffusion battery work averaged 21 cells per hour for the full campaign with a draft of 156 and losses of 0·15 and 0·09 per cent. in pulp and pulp water respectively. This speed represents 6·77 tons of beets per cub. ft. of cell capacity per 24 hours, the cell capacity being 324 cub. ft. A higher draft with correspondingly lower battery losses was found to be uneconomical because of the high cost of coal burnt.

This factory uses Roberts automatic, gear-driven, 40 in. centrifugal machines, having a speed of 1600 revs. per min., five of which work on white sugars, three on intermediates, and six on raws. Its automatic features have proved satisfactory in use. Sugar-end purities were controlled at the intermediate machines by adjustment of the automatic control to raise or lower the purity of the intermediate sugar and machine syrup.

Raw massecuite is boiled in a single calandria raw pan employing second vapour, the average cycle being slightly in excess of 5¼ hours. Following this pan are two Lafeuille crystallizers, the complete cycle of which is somewhat in excess of 10 hours. In the Steffen house, the hot sludge from the Dorr thickener flows to the cooler receiving tanks and is filtered with the cold saccharate on Oliver vacuum filters.

Steam is furnished by three 1037 H.P. Stirling type boilers, fired by spreader type stokers. An efficiency of 85 per cent. was realized for the entire campaign, due principally to the use for combustion of hot air from the top of the boilers at an average temperature of 167°F. There was practically no carbon in the ash, and the stack temperature averaged 472°F. A 2500 kw. 480-volt turbo-generator set supplies power for the factory. A synchronous 300 H.P. motor drives the five white sugar centrifugals. All motors have across-the-line starters, and the push-button switch in nearly every case is located at or near the motor.

How much Lime should One use ? M. J. SMIT. *Archief Suikerind. Nederl.-Indië*, 1940, **1**, pp. 157-160.—Observations made during the past seven campaigns at the Zevenbergen beet sugar factory in Holland have proved that the quantity of lime which must be used to obtain a proper purification of the juice should be not less than 1·5 per cent. on the beets. It is believed that mud introduced into the diffusers with the cossettes when in wet weather the capacity of the beet washers is insufficient exercises an unfavourable effect on the purity of the diffusion juice. A high lime content of the water used has the same influence.

Decolorization of Juices by the Action of Activated Charcoal and Hydrogen Peroxide. JOSEF SIMAN. *Listy Cukrovar.*, **58**, pp. 5-7 ; through *Chem. Abs.*, 1940, **34**, 6839.—The clarification of a juice for 30 min. at 98°C. with 0·02, 0·05, 0·1 and 0·2 per cent. "Norit" reduced the intensity of the colour 11·6, 17·1, 29·3 and 41·0 per cent. respectively. The clarification of the same juice with 0·02, 0·05, 0·1 and 0·2 per cent. hydrogen peroxide at 98°C. for 30 min. reduced the intensity of the colour 9·1, 22, 41 and 64 per cent. respectively. "Carboraffin" was equal to the peroxide in decolorizing power. Additions of peroxide to the activated charcoal increased the ability of the charcoal to decolorize sugar juices, but the increase did not approach the sum of the effects of the separate constituents. Peroxide did not decolorize sugar juices in the cold. Alone, or with activated charcoals, peroxide lowered the *pH* of the juices to neutrality or to the low level of 6·5. The results obtained with peroxide were of the same order as those obtained with comparable additions of chlorine to sugar juices or to activated charcoals.

Effect of the Alkalinity on the Coloration in Evaporators. SVATAVA MACKU and KAREL LANGER. *Listy Cukrovar.*, **58**, pp. 76-77 ; through *Chem. Abs.*, 1940, **34**, 6840.—The observation of DEDEK that invert sugar is frequently present in evaporators with juices alkaline to phenolphthalein is confirmed. M. and L. used 13 solutions of refined sugar with an alkalinity

[1] *I.S.J.*, 1939, p. 112.

ranging from 0 to 19, the CaO ranging from 0 to 18 mgrms. and the invert sugar from 50 to 224, and evaporated them from a 15 per cent. concentration to 60 to 65° Bg. The increase in colour was a linear function of the decomposition of the invert sugar. This decomposition could be diminished or even suppressed by a low alkalinity.

Volume of Filtering Aids in Solutions. R. BRETSCHNEIDER. *Listy Cukrovar.*, **58**, pp. 1-5; through *Chem. Abs.*, 1940, **34**, 6840.—The sedimentation volume of 3 grm. lots of diatomaceous earths and activated charcoals was noted in a 50 c.c. graduated cylinder at the end of 24 and 48 hours For 20 different brands of earths, the largest volume, 15·4 c.c., occurred with Hannover 80S, and the lowest, 6·5 c.c., with I.D.C. With eight different brands of activated charcoals the largest sedimentation volume, 27·8 c.c., occurred with "Suchar" A, and the lowest, 9·5 c.c., with "Carboraffin." The sedimentation volumes were measured in distilled water, benzene, light juices, heavy liquors and molasses. Additions of electrolytes had a marked influence on the sedimentation volume of the activated charcoals but a small one on that of the earths.

Extraction of Saturation Sediments. VACLAV KONN. *Listy Cukrovar.*, **58**, pp. 38-40; through *Chem. Abs.*, 1940, **34**, 6841.—Saturation sediments with a uniform composition and structure were extracted smoothly and completely, but sediments with an irregular structure released electrolytes and sugar at different rates and complicated the analysis of the factors involved in the extraction. The colour-polarization ratio remained constant for all dilutions. The electrical conductivity : polarization ratio rose with dilution. The changes in electrical conductivity occurring with changes in the polarization could not be predicted from the Peller modification of the Arrhenius equation. In dilute acids, alkalis or salts, sodium chloride, calcium chloride, sodium carbonate, the correlation factor between the conductivity and the sugar concentration followed the equation $K = 1 + 0{\cdot}08$ polarization; this factor held for medium concentrations of extracts. For concentrations below 2 per cent. sugar, several hyperbolic equations were developed which were not adaptable universally to dilute extracts. The failure of the latter equations is ascribed to the change of CaO in solution to Ca compounds with sucrose.

Improvements in the Operation of Diffusion Cells. JOSEF KAISLER. *Listy Cukrovar.*, **58**, pp. 45-48 through *Chem. Abs.*, 1940, **34**, 6841.—In diffusion cells the beet slices of inferior quality packed upon the supporting screen and interfered with the water flow as well as with the extraction of sugar. KAISLER tried to improve the flow by using a Pokorny cone in the cell but was more successful when he reversed the flow of the water through the screen.

Threshing and Cleaning Equipment for Beet Seed. H. W. BOCKSTAHLER and RALPH F. SEAMANS.[1] *Journal of the American Society of Agronomy*, 1940, **32**, pp. 794-802.—Machines have been devised in connexion with the sugar beet breeding investigations being carried out at Rocky Ford, Colo., these comprising the following: (1) A combination thresher and draper for individual plants or small groups of plants, which threshes and cleans at one handling plants from which seed yields of an ounce or less up to several lbs. are obtained. Seed as it comes from the draper is free from dust and stems, and further removal of small seeds by sieves or other means can readily be accomplished. (2) A suction seed separator for the separation of light, chiefly non-viable beet seed balls utilizes an up-draught of air to elevate the seed and to winnow light seed from the heavier viable component. This has been found to work very effectively; thus a seed lot germinating 86 per cent. and producing 158 sprouts per 100 seed balls was put through the separator, when it was found that the lighter portion germinated 59 per cent. with 68 sprouts; and the heavier 92 per cent. with 187 sprouts per 100 seed balls. (3) A beet seed polisher devised to remove excess corky tissues from the seed balls and to crush light empty seed balls; by removing excess cork from the seed balls, separation of the light barren seed from the heavy seed can be more readily accomplished. (4) A combination thresher and suction seed separator, which can be used with relatively large seed plots, for which a light portable outfit is required.

U.S. 200 × 215, a New Beet Variety resistant to Leaf Spot. G. H. COONS and DEWEY STEWART.[2] *The Sugar Journal* (Louisiana), 1940, **3**, No. 2, pp. 7-10.—With the stoppage of importation of foreign seed by the European war, farmers in Michigan, Ohio, Indiana and other States face seed shortages in 1942. The introduction of U.S. 200 × 215, claimed to be resistant to leaf spot, constitutes a timely release and will meet the impending emergency situation. U.S. 200 × 215, judged by the promise of its extensive evaluation tests and from the reports of growers who have tested it on a large scale, is a superior variety which may be expected to make a contribution to safe crop production.

Verticillium Wilt of the Sugar Beet. JOHN O. GASKILL and W. A. KREUTZER.[3] *Phytopathology*, 1940, **30**, pp. 769-774.—In the latter part of August, 1939, an unusual wilt was observed in beet fields in the vicinity of Ault, Colo. Isolations from the necrotic vascular tissues of the roots of affected plants yielded a species of *Verticillium*, which was capable of inducing symptoms characteristic of the disease. The morphology of the causal organism resembles closely the descriptions of *V. albo-atrum*.

[1] Bureau of Plant Industry, U.S. Department of Agriculture. [2] Division of Sugar Plant Investigations, U.S. Department of Agriculture. [3] Department of Plant Pathology, Colorado State College, Fort Collins, Colo.

New Books and Bulletins.

How to run a Water Control Analysis. By C. A. Noll. (W. D. & L. D. Betz, 235, W. Wyoming Ave., Philadelphia, Pa., U.S.A.).

This is a reprint of a series of articles entitled "How to run a Water Analysis" recently published in *Power*, the object in view being to instruct the untrained assistant in the procedure of the most important tests in water analysis, such as hardness, alkalinity, phosphates, chlorides and the *pH* value, using a kit apparatus. Each test is described with ample detail, and the steps in each essential operation is clearly illustrated by photographs taken by the staff of the McGraw Hill Publishing Co. Examples are given of the method of calculation used, and a discussion follows of the interpretation of the results obtained. This excellent brochure can be obtained (gratis) from W. H. & L. D. Betz of the address given above.

Farmers in a Changing World: The Yearbook of Agriculture, 1940. Edited by Gove Hambidge. (U.S. Department of Agriculture, Washington, D.C.). 1940. For sale by the Superintendent of Documents, Washington, D.C.; price $1·50.

Summary: Part I, "The Farmer's Changing World," is a history of agriculture in the U.S. from the colonial period to date with special emphasis on changing needs and conditions that have shaped national policies during these centuries. Part 2, "Agriculture and the National Welfare," deals with relationships between producers and consumers, agriculture and industry, farm and city people. Part 3, "The Farmer's Problems to-day," is a comprehensive survey of problems such as soil conservation and land use, farm management, foreign and domestic markets, credit, insurance and taxation, tenancy and labour. Part 4, "Farm Organizations" reports the view-points and recommendations of three national organizations of farmers in the U.S., view-points that are sometimes opposed to, and sometimes in favour of, specific policies. Part 5, "What some social Scientists have to say," in which a few representatives of different social sciences view agriculture as a whole from their particular angles. Part 6, "Democracy and Agricultural Policy," deals with the relationship of policy making to domestic processes. Part 7, "Essentials of Agricultural Policy," is an attempt to sum up what has gone before in terms of today's and to-morrow's policies.

Catching Cobwebs. By G. C. Dymond. (Knox Publishing Co., Durban, South Africa). 1940. 8s. 6d. net.

This is an entertaining travel book, written by a well-known South African sugar technologist, and covering a wide journey he made in the course of attending the 1938 Congress of the International Society of Sugar Cane Technologists at Baton Rouge, Louisiana. His itinerary lay from the Cape to Italy, where he visited Rome and Venice; Paris; London; New York; and Louisiana. Thence after the Congress he flew over the Caribbean and down the east coast of South America to Brazil, bent on a mission to ascertain how the sugar industry there produced its fuel alcohol. He finally returned to Capetown in a Japanese ship across the South Atlantic. Two further chapters describe travels in South East Africa.

The subject matter of the book is largely topical. Brief descriptions of the principal sights, shrewd comments often marked by a vein of humour on people and customs encountered, digressions to view through a scientist's spectacles some particular industry or some feature in natural history that cropped up; such go to make up the pages of this book. Oddly enough, Mr. Dymond is least felicitous in some of his references to aspects of the sugar industry, for here he tends to drop the traveller's condensed but comprehensive description for the *obita dicta* of a lecturer before a sugar association, shall we say? The result is, the ordinary reader will be left a trifle mystified as to what it is all about. But Mr. Dymond is always entertaining in what he has to tell us and we learn a good deal about the characteristics of the peoples and lands he visited; he seems to have picked a good handful of plums, in spite of the assumption (often justified) that passing travellers never reach the heart of things.

The book, published in South Africa, is attractively got up and illustrated by selections from the author's camera work. It, however, bears traces of vicarious proof reading, as some place names are mis-spelt. Thus on pages 48 and 49 "Carlisle" is thrice given as "Argyll." Then the French names which crop up in Paris and also in New Orleans are all printed without their appropriate accent marks, a blemish which rather jars on the linguist. Finally, Chapter IV is unaccountably missing. Was it blue-pencilled *in toto* by the Censor?

Money in Exports. By Walter Buchler. (Useful Publications, London, E.C.4). 220 pages. 1940. 10s. 6d. net.

This small handbook is offered to all engaged in Industry, Trade and Commerce by a widely travelled journalist. It deals briefly with the business customs of the principal countries of the world and endeavours to enlighten the reader as to the necessary methods of developing an export trade from this country to to various markets that offer. In the main it covers chiefly the small goods trade, that of articles destined for the retail trade, but even the exporter of big machinery may glean some useful hints as to the snags that face him in trying to enter some of these markets. The chapter on Japan is interesting as giving a succinct insight into the Japanese business mentality.

Indian Sugar Affairs.

Indian Export Difficulties.—Mention was made in our last issue[1] of the International Sugar Commission agreeing to allow India to export to the United Kingdom up to 200,000 tons of sugar during the calendar year 1940. The Indian Sugar Producers' Association Report for 1940 now states that owing to difficulties of freight and cost of manufacture no sugar was exported up to December 31st. The Syndicate, however, approached the U.P. Government with the request that the time limit should be extended in order to enable the factories to produce the type of sugar required for consumption in the United Kingdom. When the Report was issued, the matter was being considered by the Government.

All-India Sugar Control.—According to press reports in India, the Central Government was reported last autumn to have informed the Governments of the U.P. and Bihar that they were unable at the present time to agree to all-India legislation for the control of the sugar industry. A considerable number of sugar factories in India, including several outside the above leading provinces, as well as the Sugar Commission, remain convinced that the sugar industry should be controlled on an all-India basis, but the Central Government is disinclined to bring pressure to bear on those factories holding the contrary view, to force them into an all-India organization. Apart from the control of the factory end, there is a desire in many quarters for the various sugar marketing associations to come to terms for united action, but the position seems to be that the smaller bodies prefer the advantages accruing from their present independence and may not readily accept virtual control by the associations of the two big sugar provinces.

Ratooning in India.—The question of discouraging if not prohibiting the growing of ratoon canes by the farmers, especially in areas where cane disease is prevalent, has recently been under consideration by the authorities in Bihar and U.P. Provinces of India. It was first suggested that a differential cane price should be instituted to discourage the production of ratoons, but the idea was seen to be impracticable owing to the difficulty of distinguishing cane at the weighbridges. The Indian Sugar Producers' Association is strongly in favour of discouraging ratoon cultivation but would prefer prohibition rather than differential prices. The latter form of discouragement, in their view, would lead to ratoon cane being kept back for seed purposes which would only result in the spread of pests and diseases. The Government view is, however, that prohibition is not practicable, as it would involve large-scale interference with the cultivators, would militate against better class growers, and lead to economic loss. The Government are not, however, averse to discouraging ratooning in areas where cane disease has become serious. It has already happened that in districts where red rot was severe the cultivators have been warned that ratoon cane would not be taken by the factories.

Brevities.

Corn Sugar in U.S.A.—Corn sugar production in the United States, according to the Department of Commerce, has been in the neighbourhood of 200,000 long tons during the last few years. The peak production was in 1928 when 432,411 tons was manufactured.

Trinidad Sugar Estates.—The crop of this Trinidad sugar company during the 1939-40 season was 8,412 tons (as against 9,750 tons in 1938-39), the decrease being due to adverse weather conditions which affected the cane production throughout Trinidad. The net profit was £17,299 (against £20,868), out of which £2,000 was placed to General Reserve, which now stands at £7,000. There is a reserve also of £10,000 destined for re-housing estate workers, but so far it has not been possible to start any building schemes. With £3,765 brought forward there was available a sum sufficient to pay an Interim of 2½ per cent. and a Final dividend of 5 per cent., the two absorbing £14,625 while £4,440 is carried forward. The average price realized for the sugar was £14. 16s. 3d., compared with £12. 14s. 11d. in 1939. On the other hand, the cost of production rose from £9. 7s. 2d. to £11. 3s. 4d. The whole of the taxation payable on the profits earned to date has been provided, and the financial position of the company is described by the Chairman as being very strong.

Norwegian Sugar Supplies.—According to a news item in the *Times* emanating from Stockholm, the Swedish Red Cross recently collected a supply of sugar from Swedes who voluntarily sacrificed part of their sugar ration in order that presents could be made to Finland and Norway. But the Norwegian National Help Organization, while thanking the Swedish donors profoundly for their sympathetic intention, explained that as Norway's sugar supplies were relatively satisfactory they considered it proper to decline the gifts and thus enable the whole quantity to go to Finland.

U.S.A. 1940 Exports of Refined.—Exports of refined sugar by the U.S.A. during the calendar year 1940 amounted to 155,966 long tons, which compared with 114,594 tons during 1939, an increase of a little over 36 per cent. These exports proved the largest since 1925 when 352,154 tons were shipped overseas. The 1940 exports went to some 70 different countries, states Lamborn, France topping the list with 35,973 tons, while Greece took the next largest with 29,625 tons and Newfoundland 11,350 tons. The United Kingdom absorbed only 5,201 tons (as contrasted with 22,467 tons in 1939 and 31,735 tons in 1938); Finland and Norway, which were the second and third largest customers in 1939, took much smaller quantities in 1940, all imported in the opening months of the year before the German invasion of Scandinavia.

[1] See *I.S.J.*, 1941, p. 92.

Sugar-House Practice.

Small Steam Turbines. G. J. IRIBARREN. *Proc. 13th Conf. Assoc. Sugar Tech. Cuba*, pp. 83-86.

Two curves are reproduced to give an approximate idea of the steam rate per H.P. hour in small steam turbines. Fig. 1 gives the theoretical rate for non-condensing turbines ; and Fig. 2 the factor by which the theoretical steam rate should be multiplied to get the actual rate.

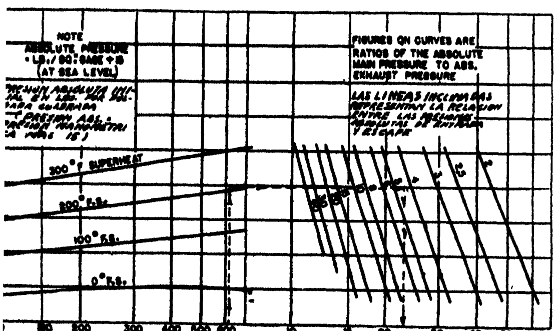


Fig. 1

For example, suppose that one wishes to find out the water rate of a 200 H.P. 3600 r.p.m. turbine operating at 135 lbs. initial gauge pressure (150 lbs. absolute) and 10 lbs. gauge (25 lbs. absolute) back pressure without superheat. Starting on the horizontal line on Fig. 1 corresponding to 150 lbs., it is followed up until the 0° *FS* curve is met, after which one proceeds horizontally to the right until the "6" line is met corresponding to pressure ratio ; from this point dropping vertically downwards 26 is read as the theoretical rate per kwh, which is equivalent to 0·746 times 26 = 19·4 lbs. per H.P. hour. Then on Fig. 2 one starts with 200 H.P. and moves vertically upwards until the curve is met corresponding to turbine No. 3 ; the factor is 2·25, and the true rate is 2·25 times 19·4 = 43·65 lbs. per H.P. hour.

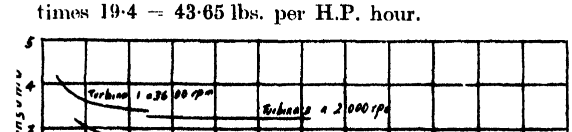


Fig. 2

Fig. 1 shows graphically the advantage of having high initial pressure and of superheating the steam, as in this way the water rate is decreased. Fig. 2 shows the curves of turbines No. 1, 2 and 3, which correspond respectively to turbines of small, medium and large size. Working conditions for all three turbines on the curves are the same (150 lbs. initial and 10 lbs. back pressure), and yet the water rate changes considerably for the three sizes.

For example : a 100 H.P. turbine at 3600 r.p.m. and working on the same steam conditions as the previous examples would have water rates of 3·38 × 19·4 = 65·5 lbs. per H.P. hour for turbine No. 1 ; 2·62 × 19·4 = 50·8 lbs. per H.P. hour for No. 2 ; and 2·42 × 19·4 = 47 lbs. per hour for No. 3. In sugar mills having small boiler capacities, or where fuel oil besides bagasse has to be burnt, it is advisable to buy the larger size of turbine with a lower water rate. Anyway, the difference in price is not much, No. 2 costing about 40 per cent. more than No. 1, and No. 3 about 40 per cent. more than No 2

As for the speed of the turbine, one notes in Fig. 2 a great increase in the water rate of turbine No. 3 as the speed is decreased from 3600 to 2000 r.p.m., it is almost 50 per cent. When installing new centrifugal pumps coupled to turbines, it is advisable to use pumps with velocities corresponding to those of 60 cycle A.C. motors, i.e., 3450, 1725, 1170, 860, etc., so that when the mill is electrified at some later date it will be possible simply to couple the electric motors to the existing pumps. However, it should be borne in mind that if the speed is under 3450 r.p.m. the water rate may be excessive, in which case it would be necessary to use a speed reduction gear between the turbine and the pump at an additional cost.

Manufacture of Inverted Molasses by a Rotating Inversion Process. J. R. OSUNA. *Proceedings of the 13th Conference of the Association of Sugar Technologists of Cuba*, pp. 245-248.

Those engaged in the fabrication of inverted molasses are familiar with the difficulties generally encountered as the result of the inadequate location of the necessary equipment. This may be avoided by the use of the process about to be described which requires only a heater, three cylindrical tanks (*A*, *B* and *C* connected to each other by 8 in. piping with suitable valves), the necessary vacuum pans, and a cooler (which may be the heater, using cold water instead of steam). Acid inversion or yeast hydrolysis may be used, and the following example will suffice to illustrate the process :

Let us assume an inflow of syrup to the tanks of 11,000 gallons per hour, equivalent to 264,000 gallons in 24 hours. Since the capacity of each tank is 33,000 gallons, eight tankfuls would have to be discharged in 24 hours, equivalent to an inversion cycle of 8 hours. Further, that the filling of tank *A* starts at 12 noon. When it is a quarter full, 30 per cent. of the amount of inverting agent calculated

for the 33,000 gallons is added, and the mixture air-stirred for 1 min., after which both syrup and inverting agent are continuously and simultaneously poured in to complete the full tank capacity. This will have taken place by 3 p.m.

At this time the filling of tank *B* will commence, following the same scheme as in *A*. It will be full by 6 p.m. As soon as the filling of *B* starts, half the contents of *A* is transferred to tank *C*. At 6 p.m. tank *B* will be full; then the remaining half of *C* is filled with fresh syrup. This tank will be full at 7-30 p.m. At this time the first 33,000 gallons will be ready for concentration. At 7-30 p.m. should commence the filling of the other half of *A*, which will be completed by 9 p.m. At this time tank *C* must be empty, its contents having been pumped to deposit tanks at the vacuum pan station, from which the pans are being continuously fed.

By 9 p.m. the second half of tank *A* will be filled, and at that moment the filling of *C* with the inverting agent starts, just as was effected in the case of tank *A* and *B*. This tank will be full by 12 p.m. In the meantime *A* is being discharged. While *C* is filled, the contents of tank *B* are divided with *A*, and at 12 p.m. fresh syrup is run into *A*, which will be full by 1-30 a.m.

It will be seen that *B* has had a 9-hour cycle, from 3 p.m. to 12, for only one-half its contents. The other half, the filling of which commenced at 1-30 a.m., has had an inversion cycle 1 hr. 30 min. longer. Although calculations were made for an 8-hour cycle, this overtime may be considered as a safety factor in the inversion until a polarization of - 15 to —16° is obtained.

This rotation is followed to completion, the same sequence being continued with absolute accuracy, otherwise all the available inverted molasses may be used, as a result of which the factory will have to be stopped. It should be observed that, at the start, the inversion cycle for *A* is 6 hrs. for the first half and 7 hrs. 30 min. for the second half; but that, thereafter, it will be 9 hrs. and 10 hrs. 30 min. for the first and second halves respectively

Power Factor Correction in Sugar Mills. C. GALLAGHER. *Proc. Queensland Soc. Sugar Cane Tech. 11th Conf.*, 1940, pp. 37-48.—Gradual adoption by the sugar mills in Queensland of A.C. for their electric drives necessitates consideration of certain problems not usually met with when D.C. is used, and of these the power factor is one of the least considered, though not one of the least importance. Most motors have a P.F. inherently less than 100 per cent., depending not only on design, but also on the load actually required. Effect of a low P.F. on a system means: Loss of capacity in generating plant; loss of voltage in transmission; and increased heating in apparatus. Methods by which improvement in P.F. can be obtained are summarized, present day practice being definitely towards correction at the motors by the installation of static condensers. As far as a sugar mill is concerned, the economics of P.F. correction lie in the direction of increased generator capacity and improved voltage drop and the costs of correction must be evaluated against such savings. For instance, the plant may be loaded to such an extent that the installation of further generator capacity is essential to take care of the increasing load. The correction of P.F. might quite easily give the necessary capacity with the existing apparatus and at considerably less cost. Alternatively the existing installed generator capacity may be ample for the load but the correction of the P.F. may be such as to enable one machine to be shut down. Naturally the savings in maintenance, etc., should be put against the amortized cost of condensers. The degree of P.F. correction again is purely one of economics, but generally speaking nothing is gained by attempting to improve it beyond 0·95.

Production of Sorghum Syrup. WILLIAM BARTLING. *Facts about Sugar*, 1940, **35**, No. 10, pp. 38-42.—Over 95 per cent. of the total sorghum syrup production of the U.S. is made on the farm in a crude way, the remaining 5 per cent. being made by two companies by modern methods, which are here described in detail. Two varieties are used, viz. (1) Red X or "Rex," and (2) the Jap or "Honey Cane," the approximate composition of their juices being respectively as follows: Brix, 19·6, 18·25; sucrose (pol.), 12·0, 8·4; invert sugar, 2·9, 7·6; ash, 1·1, 0·85; *pH*, 5·0, 5·3; colour (Pfund grader), 4·8, 4·1. Successive steps in manufacture are: Reaping with a corn harvester; removal at mill of seed heads and leaves by special stripping and cleaning machinery for sale to farmers; passage through a crusher and three 3-roller mills (26 in. dia. × 28 in.) to grind about 250 tons per 24 hours; treatment of juice with malt extract at 150°F. to convert the starch into soluble carbohydrates; clarification by adding lime and heating, using a Tolhurst centrifugal machine to eliminate the coarser solids; evaporation to a semi-syrup of 50 to 55° Brix; inversion of part of the sucrose by invertase to prevent "sugaring out"; clarification and partial decolorization by kieselguhr and carbon, followed by filtration; and finally evaporation to a full syrup of about 82 to 83° Brix at 20°C. Its composition may be: Brix, 82·85°; sucrose (direct pol.), 42·0; invert sugar, 23·8; colour (Pfund grader), 10·0; ash, 5·8; *pH*, 5·7. Processing cost in cents per U.S. gall: sorghum cane at $3·0 per ton, 19·01; labour, 5·42; fuel, 0·74; filter-aid, 2·11; carbon, 1·05; malt, 0·34; chemicals (lime, etc.), 0·10; invertase, 0·24; miscellaneous, 0·26; a total of 30·27, not including depreciation and administration, nor packing and selling.

Moisture Absorption and Elimination with Roselle and Jute Bags for packing Sugar. H. J. SPOELSTRA and G. H. BERENSCHOT. *Archief*, 1940, **1**, pp. 423-427.—Of recent years in Java bags made of roselle have come

into use for packing sugar, and so far experience has shown it to be quite equal to jute for this purpose.[1] Anyway, the Experiment Station has carried out experiments on its physical and chemical properties to ascertain if any differences likely to be of importance do exist. In this paper an account is given of investigations of the variation of the moisture content of roselle in comparison with the behaviour of jute. It is known that the moisture content of a fabric is almost wholly dependent on the relative humidity of the surrounding atmosphere, the influence of temperature changes within reasonable limits being very small. It has been shown also that sudden changes in the relative humidity of the ambient air do not immediately affect the moisture content of the fabric. Long contact is necessary, and takes place only after a great volume of air of the new humidity has come into contact with it. In these tests use was made of laboratory desiccators charged respectively with water, sulphuric acid at 28°Bé., and the same reagent at 40°Bé., in which way atmospheres were obtained in the desiccators of 100, 70 and 40 per cent. relative humidity. Inside the desiccators were placed fibres and fabrics of roselle and jute previously dried to constant weight at 105-110°C., the samples being removed at intervals and weighed to determine the moisture taken up or lost. Results were expressed graphically, and the general conclusion arrived at was that the two packing materials behave almost entirely alike.[2]

Utilization of Electrical Power in Sugar Mills. A. COYLE.[3] *Proc. Queensland Soc. Sugar Cane Tech. 11th Conf.*, 1940, pp. 65-69.—Installation of individual electrical drives in sugar mills, besides reducing the high maintenance costs incurred by the old-type long belt drive, has other advantages, such as the greater space available, the greater cleanliness, occurrence of fewer delays to process, and speed in the stopping and starting of units. A.C. equipment is considered advantageous to D.C. as it is readily available within Australia for units up to about 100 H.P., is simpler in operation, has fewer wearing parts, and has no brushes or commutators for continual attention. An outstanding advantage is the ease with which it can be changed from one pressure to another, either higher or lower, by passing it through a transformer for transmitting it long distances without any alteration to the size of lines conveying such power. Conduits in cane sugar factories should be run overhead, and totally enclosed motors used. Such motors may be cooled by various methods, one type having a large frame to dissipate heat, another having a double casing with enclosed fan blowing air between the two casings, and a third having fins radiating from the casing with a fan blowing along these fins. All types have proved very satisfactory, and some have been running at Tully for 13 years without attention other than normal slack season examination.

Mill having Boltless Housings and a Free-Floating Top Roll. *From literature published by Farrel, Ansonia, Conn., U.S.A.*—The new 36 in. × 78 in. three-roller Farrel-Scharnberg mill embodies two long-sought advances in mill design, viz., completely boltless housings and a free-floating, non-binding top roll. The hydraulic top cap and two side caps are locked in place by means of compound fishtail keys with a complete absence of kingbolts and horizontal bolts. The keys hold the caps securely and assure positive maintenance of alignment, and free vertical movement of the top roll is assured by a remarkable new anti-friction device, which consists of a series of sections of rollers of large diameter, nested loosely together with spacing washers between sections, to form a thrust block of flat plates with curved ends. These thrust plates act as individual rollers and provide true rolling contact, permitting the top box to move up and down freely with no sliding contact between the box and the housing jaw. The thrust block can be moved as a unit without disturbing the top cap or otherwise disassembling the mill. With this new anti-friction thrust-block, the motion transmitted to the hydraulic cap cylinders is direct and true. Binding is eliminated ; the entire hydraulic system is free and the accumulator is in constant motion. The result is a reduction of the hazard of broken housings due to excessive hydraulic pressure, and a drop in the power consumption.

Power Alcohol Production in the Philippines. H. W. KERR. *Proc. 14th Conf. Queensland Cane Growers' Association*, 1940, pp. 74-75.—C. W. WADDELL, of Victorias, Philippine Islands, communicates to the author particulars of an alcohol plant run in connexion with one of the raw sugar mills in the P.I. It has a capacity of 6,600 gall. of 95-96 per cent. alcohol per 24 hours ; during the milling season it draws steam from the adjoining factory, but during the slack season it uses baled bagasse as fuel. The molasses is charged for at the rate of about £1 per ton ; being rich in total sugars, the yield works out at over 69 gallons of 95-96 per cent. alcohol per ton. Only rectified spirit (95-96 per cent. alcohol) is produced, and mixed with 1-5 per cent. of petrol for use in motors adapted to this type of fuel. Adjustments required are : (1) shimming up connecting rod bearings to give increased compression ; (2) installing metal floats in carburettors while increasing the size of the jets ; (3) altering the fuel pump diaphragm to alcohol-resistant material, and (4) installing adequate screens on the fuel lines. Many engines change over to the mixture without any alteration at all. Truck and tractor trials indicate that 27 per cent. more of the alcohol mixture was required per unit of work as compared with straight petrol. Prices are : alcohol mixture, 11d., and petrol, 2s. 1d. per gallon, so that in spite of the lower efficiency of the alcohol it is economical to employ it as a substitute fuel.[4]

[1] Roselle is one of the *Hibiscus* fibres, viz., *H. sabdariffa*. Samples grown in India were examined by the Imperial Institute, London, who reported (*Jl. Imp. Inst.*, 1930, 28, pp. 284-286) that in physical and chemical properties it closely resembled both jute and *H. cannabinus*. Samples were also submitted to London brokers, who reported that it was superior to Bimlipatam jute, and valued it at nearly the same figure as obtaining for "first marks" Calcutta jute, saying that it would be saleable in London in large quantities. It is now being grown also in Ceylon, in Malaya, and elsewhere.—ED.

[2] *Jl. of the Textile Institute*, 1940, 31, p. 117.

[3] Tully Co-operative Sugar Mill, Queensland.

[4] See also *I.S.J.*, 1941, pp. 38-39.

Review of Recent Patents.

Copies of specifications of patents with their drawings can be obtained on application to the following – *United Kingdom:* Patent Office, Sales Branch, 25, Southampton Buildings, Chancery Lane, London, W.C.2 (price 1s each). Abstracts of United Kingdom patents marked in our Review with a star (*) are reproduced with the permission of the Controller of H.M. Stationery Office, London, from the Group Abridgements issued by this Department. Sometimes only the drawings are so reproduced. *United States:* Commissioner of Patents, Washington, D.C. (price 10 cents each). *France:* L'Imprimerie Nationale, 87, rue Vieille, du Temple, Paris. *Germany:* Patentamt, Berlin, Germany.

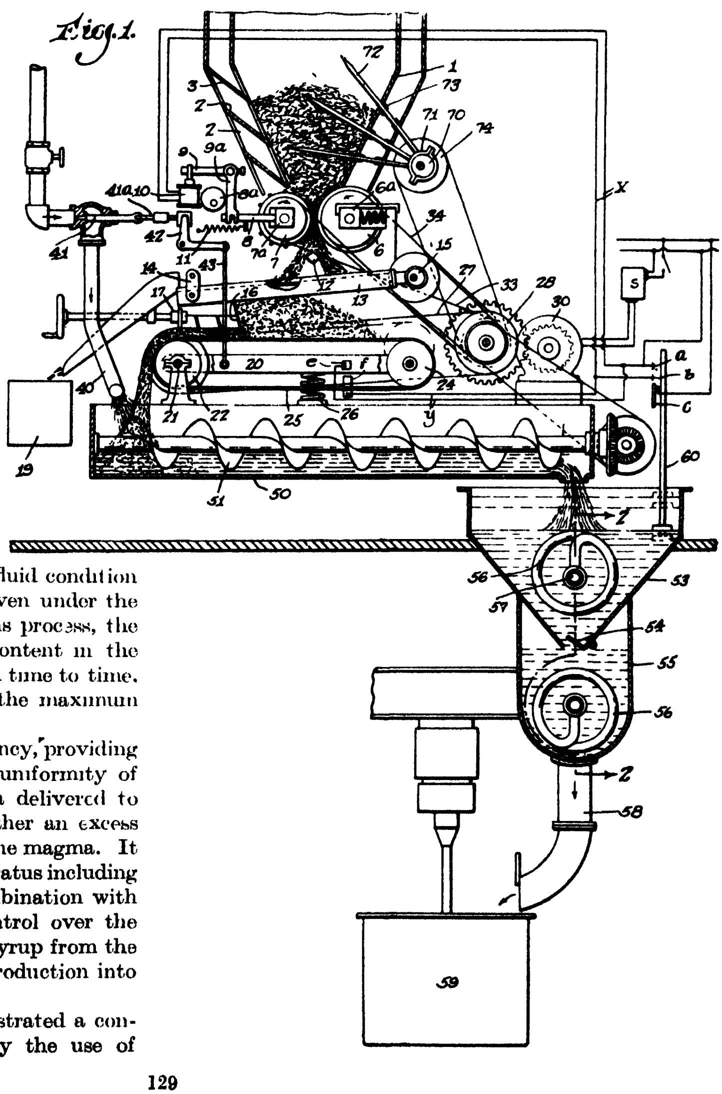
UNITED STATES.

Affination Apparatus (for mingling Sugar and Syrup prior to Centrifuging). EUGENE ROBERTS (assignor to the WESTERN STATES MACHINE Co., of Salt Lake City, Utah, U.S.A.). **2,206,237.** July 2nd, 1940.

Prior to the invention of the improved Stevens affination process of producing a mixture or "magma" of raw sugar and syrup, properly conditioned for effective centrifuging, it was generally produced by mixing together streams of unsaturated heated syrup and of raw or unrefined sugar, the condition of the magma supplied to the centrifugals depending wholly upon the carefulness and judgment of the attendant operator. Variations in the ratio of syrup to sugar were inevitable, so that magma being delivered to the centrifugals varied from time to time greatly in respect of the ratio of syrup to sugar content and viscosity, thus preventing uniformity of centrifuging. Under the Stevens affination process the magma is formed by mixing the raw sugar with a very small proportion of hot syrup in a substantially saturated condition to form a heavy, non-flowing mass, and this mass during passage to the centrifugals is heated without dilution or addition to its bulk to about the initial temperature of the hot saturated syrup, and is delivered in the resulting fluid condition to the centrifugal separators. But even under the practice of the above described Stevens process, the ratio of syrup content to the dry content in the magma is likely to vary somewhat from time to time, thus making it difficult to maintain the maximum efficiency of the process.

The present invention increases efficiency, providing a self-regulating apparatus by which uniformity of consistency is obtained in the magma delivered to the centrifugals, therefore avoiding either an excess or a deficiency in the syrup content of the magma. It comprises an improved affination apparatus including a hot mingling tank or trough in combination with distributing means for facilitating control over the flow of the mixture of raw sugar and syrup from the time it is produced until ready for introduction into the centrifugals.

In the accompanying drawing is illustrated a convenient arrangement of apparatus, by the use of which it is possible to carry out the affination process so as to avoid excess or deficiency of the ratio of syrup content to dry content, while at the same time greatly economizing in the cost of carrying out the affination process, since the apparatus can operate, after being started, under its own regulation without depending upon the faulty regulation occasioned by lack of skill or negligence on the part of the attendant. The adjustments for a given run of sugar can be



made by an expert supervisor to produce exactly the optimum conditioning of the magma being centrifuged.

Claim 1 reads as follows: In an affination apparatus, the combination of a sugar supply bin open at its bottom, co-acting spaced feed rolls located at the bottom outlet of said trough, a vibrating sieve located beneath said feed rollers, a travelling conveyor beneath said sieve for receiving and delivering a regulated stream of sugar, said conveyor being supported on a pivoted scale beam, a gauge member located above said travelling conveyor forwardly of the pivotal axis of the scale beam and co-acting with said pivotally mounted conveyor to vary the quantity delivered in accordance with variations in the quantity delivered by said feed rollers, a valved liquid (syrup) supply pipe, and means for maintaining at uniform ratio the quantities of sugar and of syrup supplied to a mixing trough, and means for mixing the sugar and liquid to a uniform consistency before conveying the mixture to the centrifugal apparatus.

Clarifying Liquids. GEORGE E. G. VON STIETZ (assignor to the SHELL DEVELOPMENT CO., of San Francisco, Cal.). 2,213,808. September 3rd, 1940.—Claim 6: In an apparatus for clarifying liquids, the combination of a vessel having a conical bottom, the apex of which projects downwardly towards the central vertical axis through the apparatus, means or centrally introducing a suspension to be clarified into said vessel and near its bottom, stirring means situated near the bottom of the vessel and adapted to prevent channeling of said suspension, means for removing a concentrated mud from a peripheral point of said vessel above the point of introduction of the suspension, and means for removing the clarified liquid at a point above that at which the concentrated mud is withdrawn and relatively closer to the peripheral top of the vessel.

Glucose-Sucrose Product. JAMES F. WALSH (assignor to the AMERICAN MAIZE PRODUCTS CO., of Maine). 2,223,925. December 3rd, 1940.—Claim 4: A process of producing a free-flowing, non-caking, solidified, starch conversion, syrup-sucrose product, containing about one-fourth sucrose and three-fourths conversion syrup and being stable against inversion, comprising treating corn syrup with a neutralizing substance to give the syrup an inversion resistant *pH* value of about 6 to 7, and to coagulate impurities and undesired substances, adding decolorizing carbon to bleach the syrup, filtering to remove the coagulated substances, blending the treated syrup and the sucrose to provide an intimate mixture thereof and spray drying said mixture to produce a stable dried product which, because of its substantial freedom from inversion products, has high resistance to caking. Claim 5: A product resulting from the treatment specified in Claim 4 and containing not more than about 2 per cent. of sucrose inversion substances, said product being substantially resistant to caking and comprising discrete particles of combined sucrose and solidified syrup.

Free-Flowing Sugar Composition. JOHN R. WHITE and JOS. A. DUNN (assignors to LEVER BROS., of Newtonville, Mass.). 2,225,894. December 24th, 1940.—Claim 9: A process of making a free-flowing sugar composition for dusting and sugaring food substances which is non-hygroscopic and resistant to staining by grease, comprising agitating and heating to about 150°F. a mixture of finely divided sugar and about 3 per cent. of tricalcium phosphate, adding to the mixture while agitating about 5 per cent. of a melted shortening having a solidifying temperature in excess of 75°F. and less than 150°F., continuing the agitation until the shortening is distributed uniformly and cooling the mixture with agitation to about 70 to 75°F. to cause the shortening to solidify and form a thin surface film on the sugar.

Treatment of Solutions and Syrups using Chlorine. PEDRO SANCHEZ and E. N. EHRHART (assignors to SUCRO-BLANC, INC., of New York). (*A*) 2,216,753; (*B*) 2,216,754; and (*C*) 2,216,755. October 8th, 1940.—(*A*) Claim 4: The method of decolorizing sugar solutions with active chlorine which comprises treating the solution with a soluble phosphate and a quantity of hypochlorite sufficient to produce a pre-determined decolorization of the solution, thereafter heating the solution to an elevated temperature whereby scum and colour form in the solution, separating the scum from the coloured solution, and then treating the solution with an amount of hypochlorite sufficient to produce substantially the same colour obtained after the first hypochlorite treatment. (*B*) Claim 2: The process of removing finely divided carbon from a sugar solution without filtering the same which comprises aerating a solution containing floc-forming materials and finely divided carbon, thereafter heating the solution to about 210°F. until the floc and collected carbon form a scum upon the surface of the solution and then separating the clarified solution from the scum by drawing off the clarified solution whereby the solution is simultaneously clarified and decolorized. (*C*) Claim 1: The method of obtaining high-grade sugar from refinery syrup resulting from sugar solutions that have been initially decolorized by hypochlorite and from which a portion of the sugar has been removed which comprises treating a run-off syrup of this origin with sufficient hypochlorite to reduce the colour thereof to a substantial extent, mixing the decolorized syrup with a clarified syrup and crystallizing sugar from the mixture.

Stock Exchange Quotations of Sugar Company Shares.

LONDON.

Company.	Quotation March 20th 1941	Quotation February 20th 1941	1941 Prices Highest.	1941 Prices Lowest
Anglo-Ceylon & General Estates Co. (Ord. Stock)	$1\frac{3}{16}$ — $1\frac{5}{16}$ per £1 unit of Stock	$1\frac{3}{16}$ — $1\frac{5}{16}$ per £1 unit of Stock	25/3	24/6
Antigua Sugar Factory Ltd. (£1 Shares)	$\frac{3}{8}$ — $\frac{5}{8}$	$\frac{3}{8}$ — $\frac{5}{8}$	8/9	8/9
Booker Bros., McConnell & Co. Ltd. (£1 Shares)	$2\frac{5}{16}$ — $2\frac{9}{16}$	$2\frac{3}{8}$ — $2\frac{5}{8}$	52/6	50/0
Caroni Ltd. (2/0 Ord. Shares)	1/0— 1/6	1/0 — 1/6	—	—
(6% Cum. Pref. £1 Shares)	$1\frac{1}{16}$ — $1\frac{3}{16}$	1 — $1\frac{1}{8}$	22/0	20/3
Gledhow-Chaka's Kraal Sugar Co. Ltd. (£1 Shares)	$1\frac{3}{16}$ — $1\frac{5}{16}$	$1\frac{3}{16}$ — $1\frac{5}{16}$	24/6	22/0
Hulett, Sir J. L. & Sons Ltd. (£1 Shares)	25/0 — 26/0	24/0 — 25/0	25/0	$22/1\frac{1}{2}$
Incomati Estates Ltd. (£1 Shares)	$\frac{3}{16}$ — $\frac{5}{16}$	$\frac{3}{16}$ — $\frac{5}{16}$	—	—
Leach's Argentine Estates Ltd. (10/0 units of Stock)	6/0 x.d. 6/6	6/0 — 6/6	6/6	6/3
Reynolds Bros. Ltd. (£1 Shares)	34/0 — 36/0	$1\frac{23}{32}$ x.d. $1\frac{27}{32}$	38/0	$32/7\frac{1}{2}$
St. Kitts (London) Sugar Factory Ltd. (£1 Shares)	$1\frac{5}{8}$ — $1\frac{7}{8}$	$1\frac{5}{8}$ — $1\frac{7}{8}$	—	—
Ste. Madeleine Sugar Co. Ltd. (Ordinary Stock)	$\frac{11}{16}$ — $\frac{3}{4}$ per £1 unit of stock	$\frac{21}{32}$ — $\frac{23}{32}$ per £1 unit of stock	14/0	11/9
Sena Sugar Estates Ltd. (10/0 Shares)	$\frac{1}{4}$ — $\frac{5}{16}$	$\frac{1}{4}$ — $\frac{5}{16}$	$6/1\frac{1}{2}$	5/0
Tate & Lyle Ltd. (£1 Shares)	49/3 — 50/3	47/6 — 48/6	50/3	46/6
Trinidad Sugar Estates Ltd. (Ord 5/0 units of Stock)	5/0 — 6/0	5/0 — 6/0	5/6	5/0
United Molasses Co. Ltd. (6/8d. units of Stock)	22/9 — 23/3	23/9 — 24/3	$25/1\frac{1}{2}$	23/0

NEW YORK (Common Shares).†

Name of Stock	Par Value.	Closing Price Feb. 10th, 1941	1940-41 Highest for the Year.	1940-41 Lowest for the Year
American Crystal Sugar Co.	No par	10	$15\frac{1}{4}$	8
American Sugar Refining Co.	$100	$14\frac{1}{4}$	$23\frac{3}{8}$	$12\frac{3}{4}$
Central Aguirre Associates	No par	$19\frac{1}{8}$	$26\frac{1}{4}$	17
Cuban American Sugar Co.	$10	$3\frac{7}{8}$	$8\frac{7}{8}$	$3\frac{1}{2}$
Great Western Sugar Co.	No par	21	$29\frac{1}{8}$	$18\frac{3}{8}$
South Puerto Rico Sugar Co.	No par	$17\frac{3}{4}$	$30\frac{3}{4}$	16

† Quotations are in American dollars and fractions thereof.

United States, All Ports.

(Willett & Gray)

	1941 Long Tons	1940 Long Tons	1939 Long Tons.
Total Receipts, January 1st to February 15th	504,241	406,974	466,619
Meltings by Refiners „ „ „	483,541	440,213	426,259
Importers' Stock, February 15th	49,865	72,851	27,199
Refiners' Stock „ „	237,530	330,479	213,143
Total Stock „ „	287,395	403,330	240,342
	1940	1939	1938
Total Consumption for twelve months	5,712,587	5,648,513	5,604,051

Cuba.

(Willett & Gray)

	1941 Spanish Tons.	1940 Spanish Tons.	1939 Spanish Tons
Carry-over from previous crops	1,181,390	588,293	729,172
Production to February 15th	300,000	480,000	700,000
	1,481,390	1,068,293	1,429,172
Exports since January 1st	295,790	271,542	267,663
Stock (entire Island) February 15th	1,185,600	796,751	1,161,509

Centrals grinding, 128, *against* 152 *in* 1940, *and* 149 *in* 1939.

The Market in New York.

During the past month the American domestic market has been firm and advancing due to several factors, the accumulative effect of which has latterly had a powerful influence upon the general outlook. Rising freight rates, the possibility of the dislocation of shipments from the Philippine Islands combined with the fact that the latest figures reveal an improvement in consumption were chief amongst these and resulted in a considerable increase in the demand for refined which in turn forced refiners into the market for replacements. Earlier purchases quickly cleared the market of nearby sugars at from the parity of 2·18 cents to 2·22 cents c. & f. New York, and subsequent business was for April/May arrival at from 2·25 cents on February 27th to 2·55 cents on March 24th. Total sales reported are approximately 220,000 tons, in which Philippine sugars participated to a large extent whilst Cuba is only credited with one cargo for early March shipment.

In consequence of the very heavy demand for refined and the rising market, refiners have marked up their quotations on five occasions during the past month, the latest advance taking place on March 19th when the general quotation was increased to 4·95 cents.

In an effort to slow down the advance, the United States Government announced on March 20th that the quota had been increased by 235,000 short tons or 209,821 long tons. Although the market was somewhat reactionary when this increase became known, the advance was resumed on the following day and is continuing up to the time of writing, quotations in the No. 3 Futures Contract on March 24th being 37 to 34 points higher as compared with our last report.

The protracted negotiations for the Cuban Loan reached a successful conclusion on March 21st, when it was announced that the Cuban Senate had passed the Bill. Prior to this, on March 4th, the Cuban crop had been fixed at 2,000,000 short tons but it is understood that the 400,000 short tons to be financed under the Loan Bill will be in addition thereto. There is no change to report so far in the general situation to affect the sale of Cuban sugar to non-U.S. destinations, but quotations in the No. 4 Contract show an improving tendency, due partly to the rise in the domestic market and partly to the passage of the Loan Bill which has resulted in some outside speculative buying on a moderate scale. At the close of the market on March 24th prices were 13½ to 9½ points higher compared with a month ago.

C. Czarnikow, Ltd.

21, Mincing Lane,
London, E.C.3.
March 25th, 1941.

Brevities.

The Mind of an Indian Ryot.—In India not only was sugar cane available in 1940 greatly in excess of requirements, but this year it looks as though much cane will fail to find a market and will have to be destroyed. As a correspondent well acquainted with India points out, the effect of this on the future of the industry is likely to be protracted, since the Indian ryot has a memory as long as that of his own elephant. An attempt made by a sugar factory a decade or two ago to get the local ryots to grow cane for the mill was met by the rejoinder "My grandfather was left with cane standing sixty years ago, so nothing doing" or words to that effect. The ryot will always remain the weakest link in the chain of supply for the Indian sugar industry.

Cuban Sugar Vicissitudes.—Speaking in Havana recently, Mr. Luis G. Mendoza gave some figures illustrating the ill effects that the war has had on the disposal of the Cuban sugar crop. He remarked that only 11 years ago Cuba produced over five million tons of sugar. In 1940 they turned out just a little more than half that amount and yet the turn of the year found them with unsold reserves of about 175,000 tons of American quota sugars and 236,000 tons of world quota sugars that should have been sold and must therefore be charged against this year's quota. And this on the top of a standard reserve of 500,000 tons for the United States market and 290,000 tons for the world market, or a total stock of some 1,200,000 tons of sugar. Yet to cut down their 1941 crop to the needs of the American and local quotas only would result in so small a crop that widespread unemployment and untold misery and distress amongst the working population would be a consequence, while at the same time unpredictable financial difficulties would be created for sugar mills operating in the average at 25 per cent. of their capacity.

Chemical Patents.—H. E. Potts, M.Sc., A.I.C., before a recent meeting of the Liverpool section of the Institute of Chemistry, said that possibly there are such things as "frozen patents" but that during 30 years' experience he had come across very few, and he thought for practical purposes the idea was an illusion. A recent article in the *New Statesman* stated that 95 per cent. of patents are "purely obstructive" but this was a gross overstatement. If an application claims a whole class of bodies, the Patent Office can call for representative samples of the members of each class. Another objection sometimes made to the British system is that too many trivial specifications are granted. In this connexion the Patent Office should be given rather wider powers. Officials in this Department are fully capable of giving a proper hearing to such cases. There is no danger in extending their jurisdiction. On the contrary, the ability to turn down trivial patents would greatly benefit all other people working in the same field. These are the real "blocking patents."

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Notes and Comments.

The War.

With the advent of Spring the Germans have lost no time in starting their 1941 campaign, and the Balkans have been the scene of severe fighting, Greece is invaded, and the British gains in Cyrenaica have been nearly all lost owing to the unexpected invasion of German Panzer divisions into Tripoli. We are once more at grips with the German army in all its mechanical might and it would be futile to speculate on what the immediate outcome will be, when every week brings its surprises and the British forces are up against new problems in tactical warfare.

The unexpected last minute decision of Jugoslavia to throw in its lot with the Allies instead of accepting the vassalage offered her by Germany unfortunately came too late to give her a chance. She certainly saved her soul, as Mr. CHURCHILL expressed it, but her quislings and her inter-racial jealousies had prevented her from allying herself at an earlier stage with her neighbours, especially with Greece, and when the blow fell it was too late to organize her defences against the rush of German forces aided by dive-bombers; and if she is capable of any further resistance it seems confined to some guerilla warfare in her mountains, where she might harass enemy lines of communication.

With Jugoslavia eliminated in a few days, Germany was able to turn to invading Greece and attacking the much smaller Anglo-Greek force stationed there to bar her progress. At the time of writing it has been for some ten days a record of a fighting retreat on the part of the Allies and of ferocious attacks by the German army and air force. For perhaps the first time since the war broke out, the Germans have met their qualitative equal and have clearly suffered huge casualties. But German strategy is invariably prepared to suffer such losses if the end can be secured and she can afford several Verduns with her enormous army. With the Allies, however, it is a case of not having a quarter of the men and equipment on the spot that they need to cope with what they have to face; so though in Greece they have retired from a front of some 150 miles to one about half that length, their task in the Greek peninsula seems to be too heavy. Probably by the time these lines are read we shall know whether they have achieved a miracle of endurance or have had to extricate themselves from a hopeless position.

The Setback in Africa.

As the Prime Minister told us, the Greek battlefield was not our own choosing, but we felt bound to come to the aid of the brave Greeks who were prepared to fight to the end even if by themselves. So we stripped the North African coast of most of the troops and equipment that just previously had rounded up 150,000 Italians, and sent them elsewhere, leaving only small garrisons to protect Cyrenaica during the hot weather which is now due. Unfortunately the British Navy cannot be everywhere, and it seems clear that too many of their units were engaged in protecting transport to Greece to allow them to patrol adequately the narrow waters between Sicily and the African coast. Anyhow, an unexpectedly large number of German transports appear to have slipped across at night and landed several divisions of Panzer formations in Tripoli. From there these raided Cyrenaica and our small forces had to withdraw to the fortified positions on the Egyptian frontier where there is a railhead. The stretched-out German forces have been halted, but they are a much nearer menace to Egypt, and the captured Cyrenaican airfields will certainly now harbour German dive-bombers, so that a sufficient British air force (which might otherwise have operated in Greece) has had to be retained in Africa to deal with them.

Fortunately, the Italian allies of Germany have not succeeded in keeping up their end in Abyssinia and Eritrea; they have lost one stronghold after another, including Addis Ababa, the capital, and though a fugitive Italian army of some size is still at large, its capture seems only a matter of time and smaller forces, so that the bulk of the Empire troops in that part of Africa are becoming fast available elsewhere and will presumably strengthen the Egyptian defensive force.

The Larger Strategy.

Whatever the outcome of the attack on Greece by the German forces massed in the Balkans, the larger strategy is the one that counts most in the end. Germany's chief lack is oil and she must to serve her ends attempt to push on till she can get the Russian oilfields on the Caspian, or the British ones in Irak, or else the Persian deposits. Thus she must invade much farther afield. A view that has come to be increasingly held of late, and seems to be that also of the British Government, is that Russia is destined to be the next victim. The rich lands of the Ukraine were to have been Germany's spoil when she defeated Russia in the 1914-18 war, and they have ever since been an ultimate German acquisition. Unless Russia is stronger in modern mechanical means to warfare than is generally assumed, these plains would not long survive an attack by German *blitzkrieg* methods; and from there an armed excursion to the Caspian oilfields might be expected. There remains Turkey. She has elected so far to hold her hand till she is actually attacked, and there is something to be said for her decision if it be the case that she lacks the air force and the mechanized army to take the offensive. But there is no reason yet to suppose that she will allow the Germans a road through her territory so long as she has any fighting power left. The recent landing of British troops at the head of the Persian Gulf brings into play a useful corridor to her back door, along which supplies can reach her from overseas.

But Germany may not confine her war ramifications to acquiring the oil sources of the Middle East. Or she may think she can secure them best by dominating the whole of the Mediterranean littoral, seizing Egypt at one end and, with the enforced connivance of the French (if not also of the Spaniards), blocking the western end at Gibraltar. If this were accomplished, a large section of the African coast might be secured as sea and air bases for attacks on British and ultimately American shipping in the Atlantic. The importance, then, of protecting the Suez Canal is one that must exceed all considerations based on European territory such as the Greek battlefield. Fortunately, the hot weather in the desert zones of North Africa will not help the Germans for some months to come. But modern mechanized warfare and flying artillery in the shape of bombers have altered all current conceptions of strategy, and the army with the greatest amount of equipment, on the ground and in the air, achieves a superiority that is not limited, as hitherto, by topographical considerations. Troop carriers, flying by night, can shift a considerable fighting force within a few hours. And Germany, protected by a ring of vassal States, fights from a centre, while we have to hammer round the periphery and are saddled with gargantuan problems of transport across the water.

Indications, then, are that for some months to come the British Empire forces will be on the defensive till the promised help from America eventuates. But to get this help we need to win the battle of the Atlantic; a defeat in this direction might well be decisive. On the other hand, if we win it in the coming months HITLER's subsidiary conquests here and there should avail him little in the end, when faced by the growing strength of British forces armed with American material. But that is a consummation that needs time, and another year seems destined to elapse before the scales turn sufficiently to ensure that when we take the offensive we can do so with sufficient force to ensure the destruction of the German power which seeks to enslave the world.

Proposed New Constitution for Jamaica.

The Secretary of State for the Colonies, LORD MOYNE, stated in the House of Lords last month, that the Government had set out proposals for certain constitutional changes in Jamaica which are being placed before that island's Legislative Council for discussion and, it is hoped, acceptance. This is one outcome of the recommendation of the Royal Commission which visited the West Indies in 1938-39, that universal adult suffrage should be introduced into the islands as a matter of future policy.

In Jamaica there is at present a Legislative Council, consisting of the Governor as President, five ex-officio members, nominated members not exceeding ten, and 14 elected members. Property qualifications are required, both for membership and for the right to vote. It would appear from this that choice of councillors and ability to vote lies amongst a very limited class of the population. The proposals for reform now put forward recommend (*a*) universal adult suffrage, and (*b*) an enlarged Legislative Council to comprise approximately double the present number of elected members, with nominated members, and three (instead of five) ex-officio members, the total number to be not less than forty. The Governor as President would be replaced by a Speaker, to be elected, after the first appointment, by the Council.

It is not proposed to carry out these changes immediately, as two difficulties have first to be faced—the absence of trustworthy statistics of population and the standard of Local Government which has resulted in unsatisfactory social services. A census must therefore be undertaken as early as possible, and local government be reorganized, after which elections can be held on the ascertained franchise. Meantime, something can be done by filling "nominated" vacancies, so that all important sections and interests of the community receive adequate consideration.

LORD MOYNE, in introducing the proposals, stressed the point that reforms like these would provide the opportunity for the improvement of local government not only in Jamaica but wherever West Indian

constitutions were bound to be altered. Nowhere was there a greater diversity than in the West Indies where the constitutions are almost as varied as the physical conditions of the island colonies. Whatever may be the ultimate future of the West Indies as a whole, we could not look for any uniform system of government in the component parts. Reforms would inevitably be called for in all these Governments, but they would need very careful examination and enquiry. Jamaica, however, was an exception; the defects and the advantages of her constitution had been the subject of very considerable controversy for many years past, and her local government institutions had been found much less developed than elsewhere in the West Indies, so that there was greater need here for the administration to be revised.

The Australian Sugar Crop.

The *Australian Sugar Journal*, writing at the close of 1940, stated that the majority of the Queensland mills completed their crushings before the end of November and the remaining mills closed down at varying dates in December, thereby bringing the 1940-41 season to a close. But a considerable amount of the sugar produced was still lying at the mills and ports awaiting shipment, and some time would necessarily elapse ere a final accounting could take place.

However, the then indications were that the total amount of sugar produced in Queensland for the season would closely approximate 763,000 tons of 94 n.t., which compares with 891,422 tons in 1939, 776,810 tons in 1938, and 762,794 tons in 1937. The New South Wales output is estimated at 45,000 tons. At the outset of the year a crop was envisaged not greatly inferior to that of 1939, but as the year advanced unfavourable conditions intervened to render that hope impracticable. In the north an unusually prolonged wet season retarded the crop growth, particularly on low-lying lands. In the central districts the wet season was of shorter duration, but subsequent spells of dry weather slowed up the rate of cane growth to some extent. In most of the southern districts the crops, other than those on irrigated areas, were seriously affected by abnormally dry weather which prevailed in all months save two. In these circumstances the output actually achieved cannot be regarded as an unsatisfactory result.

When the war broke out in 1939 and the British Ministry of Food made arrangements to purchase all the available sugar surpluses from the Dominions and Colonies, the whole of the Queensland export surplus from the record production of that year found a market and netted £2-3-3 more per ton than the export of 1938. In all, Australia exported that season 544,693 tons, which compares with the probable 412,000 tons it would have been allowed under the International Sugar Agreement. A somewhat similar arrangement was concluded in respect of the 1940 export surplus, with a further addition to the base price; though, with a production lower by some 128,000 tons, a proportionately lesser export was to be expected. But much of that export was, at the end of December, still awaiting shipment. Freight rates and other costs had increased during the year and would doubtless make a substantial offset against the increased price receivable. It was thought, however, that the export surplus from the 1940 production had a reasonable security of finding a market.

But, while the export conditions of the past two years have certainly shaped themselves most advantageously for Australian producers, it does not look as though such conditions will necessarily continue. Shortly after our contemporary made its comments, LORD WOOLTON, the Minister of Food in England, was reported as saying that shipping was so urgently needed for carrying munitions and supplying the lines of communication for the African armies that certain less essential foods would have to be ruled out for the time being, and he thought that *inter alia* the requirement of Australian sugar would probably have to be reduced. He added that only stern necessity made us at Home demand such sacrifice from the Dominions whose good will we wanted to keep.

As it is, the Australian sugar industry has already grasped the contingent possibility that their 1941 sugar crop may not find a market on the extensive scale of the past two years. But the task of making the necessary adjustment is not easily accomplished and will need careful administration. There is great need for some mechanism which will enable the industry to meet whatever export conditions may arise, without imposing greater burdens on one section of the growers than on another. A complete system of farm peaks, as provided for in the Regulation of Sugar Cane Prices Acts, operating in conjunction with the existing system of mill peaks, seems the only mechanism available to meet the situation, and it remains to be seen whether it will go far enough to adjust the situation that is bound to arise in the next few months. Anyhow, as our contemporary points out, Australia is not the only country threatened with unsaleable surpluses in the present war-ridden world; both Cuba and India are in a like position. The difficulty in each case is to practise curtailment without inflicting injury and distress on the workers in the fields. The Cuban position has been lightened by the financing of a loan which will cover some 400,000 tons of sugar this season. Will the Australian Government, we wonder, be induced to aid retrenchment in like fashion? There do not lack plans for experimentation in that Dominion to establish alternative uses of sugar, but time is a factor and any results achieved will only come to fruition in later years.

Studies in Nitrogen Nutrition.

In 1936 U. K. DAS and A. H. CORNELISON published a report on certain preliminary investigations into the effect of nitrogen on the yield and quality of juice of the sugar cane.[1] These investigations have been continued by the latter officer of the Hawaiian Planters' Association research staff and H. F. COOPER and are recorded in a recent paper.[2] The danger of a reduction of the quality of the juice as the result of excessive dressing with nitrogenous fertilizer is well known and the phenomenon is sometimes referred to as delayed maturity. The series of investigations here summarized is an attempt to discover the fundamental, underlying causes. The methods employed and the voluminous records collected are not given in detail and the results are discussed from the angle of their bearing on practical problems. The determinations themselves are derived from plots which, in addition to a basic dressing of 200 lbs. of potash and phosphate per acre, received respectively 1, 100, 200 and 400 lbs. nitrogen per acre. Irrigation was uniformly in bi-weekly doses of 2 in. per acre, or such as, with the rainfall, made the combined equivalent of 16 in. per month. Each plot consisted of 20 lines, 5 ft. intervals and 20 ft. length, giving initially 65 primary or "first order" stalks per line. Harvesting by single lines commenced at two months and continued at two monthly intervals over the 24-month period, and the canes sectioned according to age, the four months' section being that formed during the first four months, the eight months' section formed during the second four months, and the second year's growth divided into mature "dry leaf" cane, "green leaf" cane and "non-millable top."

The first results given concern growth in length. These show the natural high correlation with temperature, but they also show a definite increase in length of stalk resulting from the higher nitrogen treatments, though, once an optimum amount is reached, additional amounts give no great increase. When, however, the average mean (day and night) temperature attains 67°F., growth rate is independent of the nitrogenous fertilizer treatment. There is no direct correlation between such stalk elongation and cane weight, for the stalks on excessive nitrogen are lighter.

The 65 first order stalks make up 70 per cent. of the cane harvested. The remaining 30 per cent. is derived from secondaries arising in the fall some four months after the primaries. Later secondaries, arising in the second season, do not mature, though there appears to be a varietal difference in this matter. Death of stalks is considerable in the higher nitrogen plots; the causes are, no doubt, various and not readily determined, but they are attributed in general terms as being the result of the plant having lived a little too fast in youth.

An interesting observation is the fact that there is a definite top-to-stalk ratio behaviour for the three periods; first year with a rapidly decreasing ratio, the winter period with a less rapid decrease and the period to the end of the crop with a constant ratio of 12 to 15 per cent., and that these are independent of fertilizer treatment though there is a varietal effect. Nitrogen applications, therefore, inasmuch as they result in increased leaf weight, must form more sugars which are used in building more tissues. This leads to the conclusion that the maximum efficiency from a unit of nitrogen is obtained from early dressing against which must be placed the increased loss from disease.

The well known effect of excessive nitrogen resulting in poor juice is resolved into the problem of water, sugar and ash relationships. Excessive nitrogen is shown to lead to a proportional increase in the water content of the tissue formed under that set of conditions, and these effects are never entirely eliminated with age. On crushing, the water extracted is proportionately greater and, consequently, the extracted juice is not a measure of the true water content. Further, this additional water carries with it impurities. Actually, the per cent. of salts in the cane is reduced with high nitrogen, calcium alone, with a capacity for causing cellulose to swell and absorb water, showing an increase. With age, these effects remain, and the tissues formed under high nitrogen are more or less permanently impaired for sugar storage.

The analysis of the sucrose content of the canes at the different stages leads to a somewhat involved, because not fully proved, argument. The outstanding fact is that cane tissue formed under the stimulus of excessive nitrogen is not able to carry as much sucrose per unit volume of juice as cane lacking this nitrogenous stimulus. Some of the relevant determinations indicate that the efficiency of cane which is not nitrogen-starved (that is, the capacity of a given weight of green leaves to produce stored sucrose) is, age for age, identical for all nitrogenous treatments when the nitrogen is applied early. The inference drawn from this fact is that the differential seasonal concentrations of sucrose in the juice and in the total dry weight are due to differential utilization in the cells. Photosynthesis of sugar is not as critically affected by temperature as are growth and respiration, and the consumption of sugar in the formation of cellulose, lignin and so on under the conditions of high temperature and nitrogen supply leaves little for storage in the older cells. The reducing sugars and the organic acids are here regarded as fragments of sucrose in the process of burning. Glucose (more correctly reducing sugars) appeared in the earlier work to be inversely related

[1] *I.S.J.*, 1936, p. 270. [2] *Hawaiian Planters' Record* 1940, 44, p. 273.

to sucrose content. The present work has led to a somewhat different conception of the rôle of glucose. In corresponding tissues, decreases in sucrose are never balanced by increases of glucose and, since decreases in sucrose are generally similar throughout the entire plant, it is probable that consumption of sucrose is respiratory and localized rather than of a nature involving translocation. Respiratory activity occurs mainly in the nitrogenous materials of the cell and the increase in these materials which results from nitrogenous dressings, therefore, increases respiration. In all this there is a differential varietal response.

On cell wall substances satisfactory evidence was obtained only in the case of the uronic acids, pectin, proto-pectin and pectic acid, which latter occurs as metallic salts. Percentages of these are high in young cane but decrease with age; nitrogen treatment having no effect. These age differences appear to be due to increases in other cell wall materials rather than to any variation of the materials themselves except, possibly, at a very late stage in the life of the plant. It may be that the calcium salts of pectic acid influence the water content of these cane tissues.

Concerning nitrogen itself, the determinations include total nitrogen and what are (not quite strictly) termed amino acids—the soluble nitrogen fractions giving the Van Slyke amino acid reaction in the Cuba mill expressed juice. The two determinations form generally parallel series, except that the alpha amino acids in the top juices are, in summer, lower in the top sections and greater in the lower parts of the stalk.

As might reasonably be expected, total nitrogen in the plant bears a rough proportion to the treatment and there is a heavy uptake immediately after the application, the foliar and adjacent tissues showing the greatest response. At the basal end of the stalk there is a steady diminution with age until, below the lowest green leaf, a percentage of 0·10 on dry matter is reached. The same applies to a lesser degree above that leaf but the percentage is higher than in the basal end. Certain seasonal trends are decipherable but these are dominated by the age trends; they are, a low summer and high winter content. There is, too, evidence of a localization of the nitrogenous material in the nodal tissues immediately under the axillary buds and root primordia and, to a lesser extent, in the protoplasm of the storage cells. With age these nodal concentrations diminish at a more rapid rate than do those of the internode and they appear to be loci for storage. It is from these, but not only these, areas that nitrogenous material is translocated to the apical portion which occupies a preferential position as regards water and nutrient supply. There is here an indication of the value, from the practical aspect, of the leaf-punch method as an indicator of maturity as also of incipient nitrogen starvation in the earlier stages of growth.

In the same issue of the *Record*[1] appears a paper by R. J. Borden dealing with the nitrogen-potash-sunlight relationships as they affect the cane plant. This, again, records an extension of previous work in which no significant interaction between sunlight and nitrogen was found. The design of the experiment involved replicated Mitscherlich pots with three levels of nitrogen, average, high and excessive, and two levels of potash, average and extra, forming 12 treatments in all. For the first five months following planting at the end of December, all pots received adequate amounts of nitrogen and potash and were placed in full sunlight; subsequently the differential treatment was commenced by leaving one series in full sunlight and shading the second series from noon onwards daily. From the same date the differential dressings were: for nitrogen, 2·5, 5 and 10 grms. average, high and excessive respectively; and for potash, 2·5 and 10 grms. average and high. Harvesting took place at 12 months.

In no case was any significant gain in yield obtained as the result of the various dressings and the requirements of the crop for both elements appear to have been satisfied in all cases. The effect of nitrogen in lowering the quality of the juice was, however, very marked, the purity dropping from 89·0 in the case of average N, through 84·6 for high N to 79·7 for excessive N. Potash showed the reverse, though not very significant response, purity rising from 84·0 to 84·9.

Sunlight effect dominates the results leading both to higher yields and better juice quality from full sunlight. The actual figures for yield (average of the 24 pots) were, for full sunlight 5·04 lbs., for decreased sunlight 3·85 lbs. and for purity 88·7 and 80·2 respectively. The respective total weights of dry matter were 1125 and 798 grms. for full and decreased sunlight, with the respective figures for percentage nitrogen in the juice 0·065 and 0·131. With sunlight the limiting factor, the plants contained considerably larger amounts of non-assimilated nitrogen.

It is in the interactions between sunlight and the various dressings that the interest lies. While, under full sunlight, increased yields were obtained from high nitrogen without effect on quality of the juice, decreased sunlight not only did not result in higher yields but lowered the quality of the juice. Increased nitrogen only adversely affected juice quality in full sunlight when in excess but, in decreased sunlight, this effect was progressive. With regard to potash, the only effect of additional dressings was to increase the percentage of nitrogen in the juice in decreased sunlight. There appeared, too, to be an interaction between potash and nitrogen, in that potash reduced the deleterious effect of high nitrogen.

H. M. L.

[1] *Hawaiian Planters' Record*, **44**, 1940, p. 237.

Agricultural Progress in Antigua and St. Kitts.

In the past twenty years a revolution has taken place in the agriculture of the West Indies in which cultivation of the sugar cane plays so important a part. In this, as in other crops, the rule of thumb methods formerly applied have gradually been replaced by methods based on technical study of the underlying problems. With the establishment of the Imperial College of Tropical Agriculture in Trinidad a host of associated bodies arose around it as a nucleus in true accord with the British love of complexity of organization. Contact with the other British Islands is maintained through the Commissioner for Agriculture, a post held originally by the Principal of the College, who now, however, serves on the various advisory committees. Under these advisory committees the experimental work is conducted by the officers of the Agricultural Departments of the different Islands or, as in the case of sugar cane breeding, at a special station, the British West Indies Sugar Cane Breeding Station in Barbados. Early in the last decade a Sugar Cane Investigation Committee was established under the auspices of which field experiments were inaugurated in various Islands and reviews of the work in Antigua and St. Kitts from their commencement in 1933 to the present time have recently appeared.[1] The plan of these experiments is the work of P. E. TURNER who, for several years previously, had evolved a comprehensive scheme on parallel lines in Trinidad. These reviews summarize the conclusions so far attained, the details of the experiments on which these results are given in a series of documents published elsewhere.

ANTIGUA.

Much of the land on which sugar cane is grown in Antigua is characterized by an impermeable clay subsoil, the remaining land having a permeable marl subsoil. In the cultivation of the former, drainage plays an important part and it was in this respect that the somewhat primitive methods practised before the institution of the present work were defective. There was no systematic arrangement of the drains; ploughing was often carried out too late and ran across the drains; when these were relaid, the earth was placed on the edge thus forming a hollow bed from which drainage was poor. Root development under such circumstances could not be vigorous. Superimposed on the harmful effect of waterlogging at one season was injury to the ill-rooted plant from drought in the dry season. Slow response to rain and prevalence of root disease characterized cane growth.

Preliminary attention was, therefore, paid to drainage. Systematic siting of the drains at 25 ft. or, as was later found to be adequate, 30 ft. was introduced, the intervening beds were cambered and ploughing to a depth of 12 to 14 in. conducted along the length of these. The drains which, as a first approximation, are cut some six inches below the depth of the plough, are, thus, permanent structures not disturbed by cultivation. These remarks apply only to lands with clay subsoils; where marl subsoils occur it is doubtful if ploughing even has any advantage other than as destroying weeds.

Coincident with the above it has been found advantageous to furrow along, instead of across the bed, thus replacing hand by implement work. Again as a first approximation, six furrows form one bed. Breaking the banks, that is, returning the earth to the furrows in stages at 6 to 10 weeks after planting has been found essential for maximum yields and replaced the older practice of not earthing up. In the case of ratoons, tillage has been found unbeneficial when following the newer practices. Mulching, if it is to be of benefit, must be timed before the advent of the dry season and, even so, must be associated with a satisfactory manurial operation.

Concurrent varietal trials have led to a marked change in the varietal situation. From occupying 14 and 0 per cent. of the cultivated area respectively in 1934, Ba 11569 and B 2935 now occupy 48 and 26·7 per cent. while BH 10(12) and B 147 have dropped from 37 and 36 per cent. to 10 and 0·8 per cent. respectively.

No serious difficulty occurs in germination under the newer system but this is stimulated by soaking the sets for 48 hours in saturated lime water and using sets from land generously dressed with water-soluble nitrogen and phosphate or pen manure. Contrary to the general practice, under which only one half or two thirds of the crop was planted before the end of the year, November has been shown to be the most favourable time for planting and the practice has been adopted on some 90 per cent. of the area.

In 1932, just before these experiments were initiated, pen manure alone was used in rates up to 40 tons per acre. It has now been shown that pen manure, to give its optimum result, should be applied in dressings of 12 to 15 tons per acre and must be given ample time to decompose. Even so, its effect will vary with the season. Against its use are the facts that the economic head of stock does not yield an adequate amount, and that it is not economic to maintain a head of stock for the mere purpose of supplyimg pen manure.

Attention is, therefore, directed to artificials. On calcareous soils sulphate of ammonia alone is unreliable unless accompanied by water soluble phosphate and even on non-calcareous soils such phosphate is found advisable. The advantage of pen manure appears to lie in the readily available phosphate and

[1] *Tropical Agric.*, 1940, 17, pp. 208 and 226.

nitrogen content. Sulphate of ammonia and phosphate, if superimposed on pen manure, may negative the benefit of the latter and are alone capable of giving as large or larger gains in yield. The general practice recommended is to distribute the available pen manure over the entire area of plant cane and add a dressing of 2 cwts. sulphate of ammonia and 2 cwts. superphosphate or the equivalent of ammonium phosphate and, for ratoons, this inorganic dressing. Filter-press mud can advantageously be used in place of pen manure. Here a time factor is of importance owing to the concentration of readily available calcium; the inorganic fertilizer must be applied early, within a month of planting, perhaps even earlier. The above recommendations for the dressing for ratoons is provisional only and more information is required. The extent to which these practices are being adopted in general practice is indicated by the amount of phosphate (P_2O_5) imported which has risen from nil in 1932 to 59·6 tons in 1939 while that of nitrogen (N) from 67·9 to 93·6 tons between 1936 and 1939. It will be of interest to see whether any cumulative effect becomes apparent from this extended use of artificials.

Where the complete schedule based on these findings has been adopted, advantages additional to that of yield have resulted. The cost of planting is diminished and longer ratooning becomes practicable. It is probable, in fact, that much of the abandoned cane lands could be profitably brought back into cultivation. Owing to the very variable rainfall, yields necessarily fluctuate widely from year to year and it is possible to measure the trend of effective change resulting from these changes of practice over a considerable period. In the present case the adoption of the newer practices is still not universal but a rough idea is given by a comparison between the average estate yield for the two periods 1925-32 and 1933-40. These are, respectively, 14·7 and 18·4 tons cane per acre; an increase of 3·7 tons or some 25 per cent.

St. Kitts.

The summary of the investigations in St. Kitts follows the same lines. St. Kitts is a smaller island than Antigua and more mountainous, lacking the coral formations of the latter. This is reflected in the cultivated areas which, in the absence of any extensive plains, cover the slopes. From the agricultural point of view, they fall into three groups, lower, middle and upper lands. The first of these are, in general, deep and fertile lying as they do at the foot of the glacis. The last are of variable depth, severely depleted by erosion and, consequently, less fertile. The middle lands have intermediate characteristics. All soils are easy to work; though the upper and some areas of the middle lands tend to become compact, drains are nowhere necessary. Cutting across these soil types is a variable rainfall, usually abundant to the upper lands and, generally, ample except in certain tracts of the middle lands where moisture becomes definitely the limiting factor.

Ploughing has not, in the past, been practised and the general conclusion is that there is nothing to be gained from the operation. On the deep soils no benefit has been found; on shallow soils of the upper lands, while it may aid root penetration, it may also lead to serious erosion. Furrowing only is practised, by hand on the steeper slopes and by cattle-drawn implements in the more accessible areas, new furrows being made between the previous rows. Previously little attention was paid to the direction of the furrows and erosion was partially controlled by cross-barring the furrows. The introduction of contour furrowing, which is becoming generally adopted, removes the need for cross-barring. Chiselling the bottoms of the furrows is recommended but requires to be timed. Depending for success on a shattering, rather than a cutting effect, it is best done in the dry season. In the shallow soils deep furrowing is recommended prior to chiselling and at a time when these furrows will become partially filled with weathered soil. Interculture after planting has not proved beneficial on deep soils and, in dry seasons, may prove harmful; on compacted lands it is of advantage. Breaking the banks is not essential.

The older customary procedure was to range the trash on alternate strips between the rows and to cultivate the strips left bare, sometimes transferring the trash and cultivating the newly exposed strip. In no case has benefit been found from such a practice and it has been found adequate merely to remove the trash from the immediate vicinity of the stool to prevent smothering. In the dry areas, particularly in dry years, mulching both with trash and bagasse has given rise to large increases of yield. Mulch deeper than 3 in. bagasse and 6 in. trash is harmful as absorbing in itself any light rain. Delivered as it is in the form of compressed bales, bagasse offers an economic problem in the best means to spread it evenly. Mulching is not likely to become an economic proposition in wet areas.

As in Antigua, the varietal position has undergone a marked change in recent years. In 1933 the two standard varieties were BH 10 (12) and SC 12/4; the former on the drier low lands, the latter on the upper, middle and wetter low lands. The former has been completely replaced by B 2935 which has also largely replaced BH 10 (12) on the wetter low lands, and on the drier middle and upper lands. In 1937 B 2935 occupied only 3·3 per cent. of the cultivated area whereas, in 1940, it occupied 47·8 per cent. A still newer variety, B 3439, has already been proved superior to B 2935 for late reaping on the drier low lands and shows promise on the wetter low lands and the drier middle and upper lands.

Here again, time of planting has been found to have a material effect on the resultant crop. Maximum yields result when planting is undertaken in

late August or early September on the upper lands and at progressively later dates downwards, with the drier low lands about mid October to December. Where the young cane makes rapid early growth, a process known as forcing back may be adopted. In this, cane is planted a few weeks before reaping and the cane reaped in one, instead of two years. Under this process, the soil remains uncropped for a few weeks instead of many months and loss of organic matter is reduced.

On the upper and wetter middle lands germination is poor if planting takes place after the end of October, probably because the planting material is over-mature. On the lower lands, provided late planting is avoided, germination is excellent. The optimum spacing distances have been found to be 4·5 ft. × 4 ft. in the drier, and 4·5 ft. × 3 ft. in the wetter areas.

Liming on the middle and upper lands, which are acidic as opposed to the neutral lower lands, has given an immediate and residual paying return with an optimum economic dressing of half the lime requirement, and a field to field survey of lime requirement has been instituted. That a practical response is being made to this finding is shown by the imports of crushed limestone which have risen from nil in 1935 to 670 tons in 1939.

Pen manure, supplemented by fish manure, at the rate of 20 to 30 tons per acre is the common practice on the lower lands but, on account of their inaccessibility, the upper and middle lands are rarely dressed. On these porous soils decomposition is rapid and full prior decomposition is not necessary. The evidence shows, however, that such organic manures are not essential, being replaceable on the dry lands by a complete inorganic fertilizer with a mulch of bagasse. Gains from molasses have given small but uneconomic gains.

As the result of a large number of experiments between 1933 and 1940, conclusions have been arrived at concerning the optimum both in amount and in time of application of dressings of inorganic fertilizers. In the case of nitrogen both early and late applications are necessary. On the drier lower lands 1 cwt. sulphate of ammonia early and 2 cwt. late are advised; for the drier middle and upper lands, 2 cwts. early and 2 cwts. late and for the wetter lands of all classes. 2 to 3 cwts. early and 2 to 3 cwts. late. For ratoons, 3 cwts. applied immediately after reaping is recommended.

Paying responses to potash occur over a wide area but the economic dressing is linked with rainfall, the requirement for a given value for exchangeable potash being greater in a wet year. Unfortunately pre-knowledge of the nature of the season is not obtainable and an approximation to the optimum dressing only can be recommended. These dressings are, over 130 p.p.m. exchangeable potash in a wet, and over 100 p.p.m. in a dry season, nil; 130 to 100 and 100 to 80 p.p.m. respectively 1 cwt. potash as muriate; 100 to 70 and 80 to 60 p.p.m., 1·5 cwts.; under 70 and under 60 p.p.m., 2 cwts. or more. For ratoons a dressing of two thirds of the above in the absence of pen manure and, for later ratoons even after pen manure. Field to field surveys are under way and the extent of the adoption of the recommendations is indicated by the imports of muriate which have risen from nil in 1932 to 201 tons in 1939.

Phosphate in the form of superphosphate has been found to give an economic return on lands not pen manured and a dressing of about 1 cwt. per acre is recommended for such lands, applied with the early dressing of nitrogen and potash. After such a dressing to plant canes none need be given to ratoons. Here, again, the extent of the adoption of the recommendations is given by the imports of superphosphate which have risen from nil in 1932 to 201 tons in 1939.

The changes which the adoption of the recommendations arising out of this work has effected between 1933 and the present time, are varied. There has been an increase in the acreage from some 7,700 to 9,700 acres, approximately a 25 per cent. increase. This arises from two sources. Some of the less intrinsically fertile upper lands, previously uneconomic, have been brought under cultivation. Again, some of the shallow soils yielded only a payable crop of plant canes and required a period of rest under pigeon pea. These are now largely under continuous cane with ratoon crops in addition to plant canes. Ratoons or a larger number of ratoon crops are also obtainable on the wetter lower lands and on the deeper and more fertile soils.

Owing to the variable rainfall, to the brevity of the period and the present partial adoption of the recommendations, it is difficult to obtain a clear measure of the benefits derived as a whole by the island. Certain figures are given, however, which indicate that these are considerable. Comparison between the two years 1931 and 1936, both dry years, show an increase of island yield of cane from approximately 100 to 200 thousand tons with the respective yields per acre 16·1 and 23·7 tons. In 1932 and 1939, years of medium rainfall, the island output figures rose from 164 to 262 thousand tons and the yield per acre from 25·13 to 27·16 tons. In the wet years 1934 and 1937 these figures rose respectively from some 200 to 256 thousand tons and from 26·23 to 28·41 tons. Part of the island increase of production is due to extension of the cultivated area. Such extension, however, has been obtained by the inclusion of less fertile areas and it is in spite of this fact, with its natural tendency to reduce the average yield, that an increased average yield per acre has been obtained.

H. M. L.

Economizers *vs.* Air-Heaters.[1]

By G. H. JENKINS.

Since our tests on furnace investigations[2] led to certain conclusions regarding the relative merits of air-heaters and economizers which are contrary to some accepted ideas a discussion on the subject should be of interest. Air-heaters and economizers have been discussed with reference to sugar mill practice by VON PRITZELWITZ VAN DER HORST and a Queensland Committee, with conclusions favouring the former, the principal reasons given by the Committee being :—

(*a*) With feed water at 200 to 220°F., and the usual boiler pressures used in sugar mills, the gain in heat offered by an economizer with the permissible rise in water temperature is relatively small, whereas, with an air-heater, the heat recoverable may be considerably higher, being limited mainly by the heated air temperature and the permissible furnace temperature. VON PRITZELWITZ estimates the maximum saving for typical sugar mill conditions as 7 per cent. of the fuel with economizers and 13 per cent. with air-heaters—the latter figure being based on a heated air temperature of 180°C. (356°F.).

(*b*) As a further consequence of the high initial feed water temperature, the available temperature difference between gas and water is much less than that between the gas and air at atmospheric temperature, hence a large economizer heating surface is required for a given heat recovery.

(*c*) Since the economizer works at full boiler pressure and the air-heater practically at atmospheric pressure, the cost per unit heating surface is higher in the former case. This combined with the greater heating surface (see (*b*)) involves a considerably higher initial cost for a given heat recovery with an economizer.

(*d*) With pre-heated air, some improvement in combustion efficiency is obtainable, which is especially valuable with a wet fuel such as bagasse.

As a result of such published statements, it has generally been accepted in Queensland that the economizer was not worthy of serious consideration in competition with the air-heater, but some further factors are involved, which appreciably modify the conclusions quoted. They will now be discussed.

The reasoning given under (*a*) deals with the question of the maximum heat recovery possible. In practice, however, this question is usually of minor importance compared with that of the maximum *economic* heat recovery which is governed by considerations (*b*) and (*c*). Especially is this the case in sugar mills where, until someone takes the trouble to develop an economic outlet for surplus bagasse, the desired gain in efficiency of boiler plant is strictly limited. Discussion of the question of maximum possible heat recovery will therefore be given later as not being of immediate importance.

Cost of Heating Surface.—The heat recovery economically obtainable depends mainly on the cost of the heating surface, which in turn is governed by the area required, and the cost per unit area. The heating surface for a given heat recovery depends not on the *initial* temperature difference as cited in (*b*), but on the *average* temperature difference between the two fluids concerned. The heat transfer coefficient is also of prime importance. Considering the latter first, heat transfer coefficients from metal surface to a liquid are far greater than those from metal to a gas. Hence the overall coefficient of heat transfer from gas to water, through a metal surface, will be of the order of twice that from gas to air, if gas velocities are similar in both cases. This conclusion is confirmed by the figures from the Bingera tests (see Table) giving high heat transfer coefficients compared with those for air-heaters in previous tests. This factor therefore favours the economizer and partially offsets the disadvantages of low initial temperature difference.

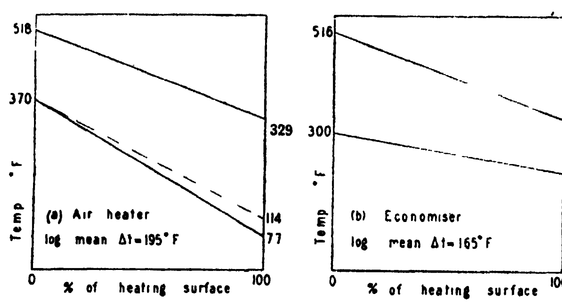

Fig 1.

The effective temperature difference between gas and air or water is the logarithmic mean of the temperature differences at inlet and outlet. The value of this depends, not only on the initial temperatures of gas and water (or air) but on the temperature rise of the latter relative to the temperaature fall of the gas. For average conditions with an air-heater, the temperature rise of the air is about 1·5° for 1° fall in gas temperature, while the corresponding figure for water in an economizer is about 0·5.° Therefore, assuming counter current flow in either case, which is approximately true for most designs, the temperature difference in the air-heater will *decrease* considerably from air inlet to air outlet, while in an economizer, the temperature difference between gas and water will *increase* as the water passes through the economizer.

[1] Part of *Technical Communication No. 4 of* 1940 ; Bureau of Sugar Experiment Stations, Brisbane. [2] *I.S.J.*, 1941, pp. 52-54.

This is shown in Fig. 1, based on actual temperatures from tests ; for simplicity it is assumed that the rates of temperature change are such as to give straight-line graphs. Hence, compared with the air-heater, the average temperature difference in the case of the economizer is not as small as would appear from the initial temperature of the water. Where re-circulation of air is practised to avoid corrosion of the air-heater, the temperature difference in the latter is further reduced somewhat, as shown by the dotted line in Fig. 1 (*a*). Where delayed combustion takes place in the air-heater or economizer, the relative temperature rise of air or water will be greater than the figures given above, but the foregoing reasoning is not affected thereby, except to accentuate the diminishing temperature difference in the air-heater.

The combined effect of heat transfer coefficient and average temperature difference is shown in the total heat transmission per unit heating surface. As seen in the table the figure for the economizer in Test 2 at Bingera is greater than for any of the air-heater tests except those at Fairymead in 1936, where a small air-heater was operating at high flue gas temperatures, and consequently high temperature differences. It is thus clear that high total heat transmission rates can be obtained in an economizer with gas velocities which are well within the limits of practical operation with induced draught alone. With modern economizers with gilled tubes in staggered formation and arranged for better counter-current flow and elimination of air leakage, this statement would doubtless apply even more forcibly.

With the large variation, in the tests on air-heaters, of heating surface, gas temperatures, evaporation rates, and probably also in gas velocities, it is difficult to arrive at a precise comparison of the relative heating surfaces required for an air-heater and an economizer for a given heat recovery. The indications are, however, that the economizer heating surface would be no greater, and would probably be somewhat smaller, than the air-heater surface for the same duty. The relative initial costs, therefore, become mainly a matter of the cost per unit area of the respective heating surfaces, and will probably be somewhat higher for the economizer than for the air-heater. On the other hand, to afford a fair comparison, the cost of forced draught fan and drive must be added to the cost of the air-heater proper.

Heated Air and Water.—The beneficial effect of heated air on combustion efficiency is a definite point in favour of the air-heater, especially with wet fuels. The tests on the Bingera installation, however, show that even with a very low proportion of excess air, combustion was almost complete with cold air ; and as stated elsewhere in this communication, it is possible that a slight alteration in combustion chamber design would improve the work to the extent of ensuring complete combustion. Thus it appears that with bagasse of less than 50 per cent. moisture, good combustion work may be obtained without air pre-heating. Where such is the case, the addition of an air pre-heater without due regard to design of furnace and combustion chamber may easily give rise to trouble with high furnace temperatures and excessive maintenance on brickwork. Thus the effect on combustion work may prove a liability rather than an asset.

Apart from the saving in sensible heat loss in the flue gas, a secondary beneficial effect may also be obtained with an economizer, viz., improvement in heat transfer in the boiler, with a consequent gain in the efficiency of the boiler itself. This has already been mentioned in discussing the flue gas temperatures for the Bingera tests, and is quite distinct from the increase in evaporation *rate* due to hotter feed water. The gain so obtained may be quite as important as the improved combustion efficiency due to pre-heated air.

Corrosion.—Liability to corrosion has been suggested by the Queensland Committee as a point against the economizer. More recent experience in Queensland, however, indicates that air-heaters are susceptible to serious corrosion even where considerable re-circulation of hot air is practised. With an initial feed water temperature of 200 to 220°F., on the other hand, it is difficult to see how any risk of corrosion can be incurred with an economizer, when

AIR-HEATER AND ECONOMIZER DATA—TESTS 1936-39.

Mill and Boiler Unit :	Fairymead No. 5			Pioneer			Bingera	
Heating surface of air heater or economizer per cent. H.S. of boiler†		65*			98		80	
Test No. :	7	8	12	2	3	4	1	2
Boiler evaporation, lbs./sq. ft./hr.	4·7*	4·7*	5·5*	5·9	5·6	4·9	4·6	6·0
Gas temp. leaving boiler °F.	590	590	594	500	500	482	461	572
Final gas temp. °F.	464	464	466	369	367	356	280	377
Ratio : $\frac{\text{Temp. rise of air (or water)}}{\text{Temp. fall of gas}}$	2·1	2·1	2·0	2·0	2·0	2·0	0·43	0·48
Total heat transmission, B.T.U./sq. ft./hr.	950	1,040	980	610	564	672	441	697
Heat transfer coefficient, B.T.U./sq. ft./hr./°F.	3·4	3·8	3·5	3·4	3·0	3·6	4·1	3·3
Heat recovery per cent. gross c.v.‡	6·9	7·5	5·8	6·3	6·3	7·5	5·2	6·0

* Including water tubes in furnace as part of boiler heating surface. † Using maker's figures for heating surfaces in all cases.
‡ Based on temperature of air leaving heater for air-heater tests, but on temperature of water entering boiler for Bingera unit, as measurement of temperature leaving economizer was not practicable.

the dew point temperature of the flue gases will range from 140° to 155°F. for practical values of bagasse moisture and CO_2 content of flue gases. It is perhaps only fair to add that in cases of air-heater corrosion in Queensland, including that cited, the re-circulated air temperature had not been kept up to the dew point of the gases. According to ROBEY and HARLOW this is the only sure method of avoiding corrosion.

Cost Considerations.—It has been suggested that an air-heater will generally be easier and cheaper to install than an economizer. While this may well be true of the older type of vertical tube economizer as used at Bingera, the new types with horizontal gilled tubes, compactly arranged behind the boiler would probably be quite as simple to install as an air-heater. The initial cost of the economizer may be somewhat higher, but working costs will probably be lower due to lower maintenance on the economizer, and the absence of the forced draught fan and drive, with attendant power and maintenance costs. Hence it is possible that the economizer will show a lower total annual cost and offer a better propositon. The foregoing remarks are based mainly on a comparison of the plate type of air-heater, with the familiar vertical tube type of economizer. Tubular air-heaters would probably show a higher cost for a given performance, but on the other hand, the rotary type of air-heater offers certain advantages. The gilled tube economizer again appears attractive, but no data are available as to costs or operating results with bagasse fired boilers, for either of these less familiar types of equipment.

Maximum Heat Recovery.—With the development of economic uses for surplus bagasse, it is probable that, in the future, the maximum heat recovery possible will be sought in bagasse-fired boiler installations. In this case the question of maximum recovery may become of importance. The heat recoverable in an economizer is, of course, limited by the initial feed water temperature and the temperature to which the water may be heated without risk of boiling in the economizer. VON PRITZELWITZ recommends a safety margin of 40°C. between the water leaving the economizer and the boiler temperature. EIGENHUIS suggests 20°C. If the latter figure is taken in conjunction with the other figures of VON PRITZELWITZ, the heat recoverable by an economizer, instead of his figure of 7 per cent., becomes 10 per cent. of the fuel requirements for a boiler pressure of 8 kg. per sq. cm. (114 lb. per sq. in. gauge). With higher boiler pressures, the permissible temperature is naturally higher, enabling a greater heat recovery to be realised.

Fig. 2, which is based on a "safety margin" of 20°C. illustrates this graphically, and shows, for different boiler pressures, the permissible saving in heat in the economizer. This saving is expressed as a percentage of the total heat to be given to the original feed water to convert it to saturated steam at the boiler pressure, or as the percentage saving in fuel for a given evaporation. It may be mentioned in passing that in the tests on the Bingera installation, the "safety margin" of temperature was considerably higher even than the figure suggested by VON PRITZELWITZ, indicating that a larger economizer and a greater heat recovery would be technically practicable. The actual gain obtained in Test 2, with a boiler pressure of 208 lb. per sq. in. gauge, was about 10 per cent. on fuel (6 per cent. on calorific value) or equal to the maximum permissible for the conditions given by VON PRITZELWITZ.

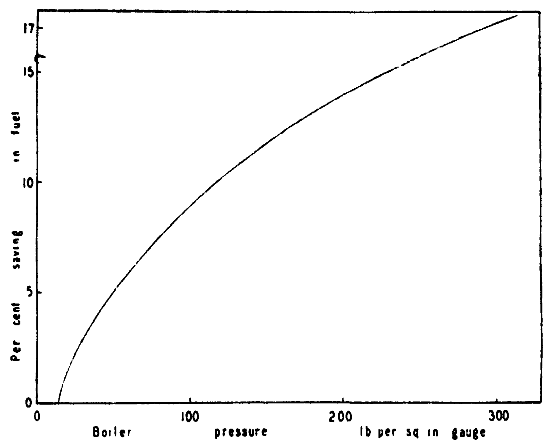

Fig. 2.

With the air-heater, the heat recovery practicable is limited mainly by the allowable heated air and furnace temperatures; and the figures of the 1938 tests at Kalamia, with a heated air temperature close to that postulated by VON PRITZELWITZ show a saving in fuel very close to that calculated by him. With suitable furnace design, however, there is practically no limit to the permissible air temperature. In this connexion it is of interest to mention the recent trend of power plant practice where, partly on account of the high feed water temperatures obtained by bleeding vapour from the turbines, air-heaters have, to a great extent, proved more attractive than economizers.

Concurrently with the use of pre-heated air, water-cooled furnace walls have been adopted to avoid the excessively high furnace temperatures and high maintenance of refractories which would be incurred with furnaces of earlier designs if used to burn black coal with pre-heated air. The author considers that a similar development, coupled with the use of highly pre-heated air, may well take place in the future with bagasse-fired boilers.

In practice, the heat recovery obtainable with an air pre-heater is also limited by the average temperature difference between gas and air; and as

already stated, this is influenced by the ratio of rise in air temperature to fall in gas temperature. If high recovery is attempted with a moderate initial gas temperature, the temperature difference between gas and air at the hot or air outlet end of the heater will become too low for a practical rate of heat transfer. This effect, which has been fully discussed by ROBEY and HARLOW in connexion with coal-fired boilers, would be much more marked with bagasse, where on account of the high moisture content of the flue gases, the ratio of temperature changes is about 1·5 compared with about 1·2 for coal.

The figures quoted by VON PRITZELWITZ, incidentally, postulate a ratio of 1·17 which is more applicable to coal than to bagasse. ROBEY and HARLOW recommend the use of an economizer as well as an air-heater to permit of high heat recoveries with reasonable temperature differences and heating surfaces. The combination of economizer and air-heater is, in fact, a general feature of large and modern coal-burning plants, and may well be employed in future bagasse-fired boilers when the utmost efficiency is required, in which case the use of both units, especially with large boilers, would not offer a serious complication. For immediate requirements of a moderate increase in efficiency with existing or conventional furnaces, it has already been suggested that the economizer may not only be a formidable rival to the air-heater but may even prove more economical.

Agricultural and Technological Observations.[1]

By Dr. C. A. BROWNE.

Dr. HONIG has asked that I give "a review of my ideas and work for the younger generation in the Java sugar industry." A review of this kind must necessarily be based upon individual experiences. I hope, therefore, to be pardoned for the more or less reminiscent character of my observations with different sugar-producing crops of America.

My first experience in sugar technology was gained some sixty years ago as a boy on a New England farm when during early March I boiled down the sap of maple trees in brass kettles to make maple syrup for use on the breakfast table as a sweetener for fried cakes. Maple syrup has been used for this purpose in America since early colonial times and it still ranks, because of its attractive flavour, as the most desirable and highest-priced liquid sweetening agent on the American market. If the syrup is still further concentrated and then poured into moulds it hardens into cakes of sugar which, because of its delightful aromatic flavour, finds a ready market as a confection.

The high price of genuine maple products has led to their frequent adulteration. The volume of the lead precipitate has been used to differentiate between pure maple products and those adulterated with sucrose, but unfortunately this test is not always reliable. Certain muscovado and mat sugars, which contain the natural acids, etc., of the cane juice, give a volume of lead precipitate closely agreeing with the value found for pure maple sugar and syrup. An analysis of the ash and a determination of the ratio of water-insoluble to the water-soluble ash is often of value in detecting this form of adulteration.[2]

Researches conducted by NELSON, of the U.S. Bureau of Chemistry and Soils (with which the author has been connected during the past 17 years) afford several indicia of identification. The organic acids of maple syrup[3] were found to consist of l-malic, citric, formic, acetic, fumaric and succinic acids. The granular deposit of maple sugar "sand" (the organic calcium salts which form in the evaporating kettle during the concentration) was found by NELSON[4] to contain, in addition to all the above acids, traces of l-tartaric and tricarballylic acids; aconitic acid, the predominant organic acid of cane juice, is not present in maple products. NELSON's investigation of the characteristic flavour of maple syrup showed that it depended largely on an unstable phenolic constituent which is associated with a crystalline aldehyde (m.p. 74 to 76°), similar in odour and properties to vanillin.

The sucrose of maple sap is a hydrolytic product that is formed in early spring from the starch that is deposited in the trunk of the tree as a reserve carbohydrate before the approach of winter. In the early spring of 1907, the writer attempted to isolate the enzyme that is responsible for this transformation but was unsuccessful. The conditions of its activity and separation still remain to be worked out.

The next sugar-producing crop with which I became familiar was the beet. In 1896, when I was beginning my career as an agricultural chemist at the Pennsylvania Agricultural Experiment Station, many farmers in different districts of the United States began to plant small areas with this crop in an experimental way and sent samples of the beets that were harvested to the State experiment stations for examination. Among my miscellaneous duties was

1 Abridged from an article entitled "Agricultural and Technological Observations with different Sugar-producing Crops," published in the *Archief Suikerind. Nederl.-Indië*, 1940, 1, pp. 194-202.

2 "Handbook of Sugar Analysis," pp. 516-520 (1912). 3 *J. Amer. Chem. Soc.*, 1928, 50, p. 2006. 4 *Ibid.*, p. 2028.

the testing of such samples. I became intrigued with the possibilities of sugar-producing crops in the United States, and this resulted in devoting myself intensively to a special study of sugar chemistry and technology for the next several years. Accordingly in 1900, I went to Göttingen University in Germany, where for four semesters I studied under Prof. B. TOLLENS.

The laboratory of TOLLENS at that time was a most cosmopolitan place. An atmosphere of international good will and cordiality prevailed among the students of the different nations, both in the laboratory and classroom and also on the technological excursions that were taken to beet sugar factories in the neighbourhood. It is sad to think that these pleasant relations no longer exist.

The close interrelationship of agriculture, economics and industry was impressed most strongly upon me when, after my return from Germany, I joined in 1902 the staff of the Louisiana Sugar Experiment Station under the directorship of the late Dr. W. C. STUBBS. It was he who saved the Louisiana cane sugar industry from disaster by the introduction of the new D74 and D95 seedling canes from Demerara. Students from all parts of the world were trained at the Audubon Sugar School in the agriculture and technology of sugar production. Dr. STUBBS was a firm believer in keeping the experimental work of his station in close contact with practical plantation requirements. The sugar planters and station scientists met monthly in the rooms of the Louisiana Sugar Planters' Association for a discussion of problems, and papers and discussions were published in the weekly journal of the Louisiana Planters' Association. The value of such an organization and publication in maintaining close constant correlation between the field and factory work of the plantations and the scientific investigations of the station cannot be too strongly emphasized.

The past generation of sugar planters in Louisiana was the best educated and most progressive group of agriculturists in the United States. Many of them had followed the old Creole tradition of obtaining the final part of their education in France. The practice of some Louisiana sugar planters a hundred years ago of sending their sons to the technical schools of France bore splendid fruit in the development of several prominent sugar technologists, of whom NORBERT RILLIEUX, the inventor of multiple effect evaporation, was the most brilliant example. The recent erection of a memorial tablet to RILLIEUX in the old Cabildo of New Orleans by the sugar industry of the world, under the initiative of Dr. PRINSEN GEERLIGS and other sugar technologists of the Netherlands, was a most cordial and friendly act of international recognition. With the passing of the former generation of sugar planters in Louisiana, their agricultural association and journal also vanished from the scene. The educational, industrial, economic and social advantages of these institutions cannot be over-estimated and their disappearance can be viewed only as a great calamity.

In 1903, the writer in his work at the Louisiana Experiment Station began a study of the hydrolytic products of sugar cane fibre.[1] Paper and fibre-board of excellent quality were made from bagasse at this time and manufacture was attempted on a small scale, but the processes were not economical, due chiefly to the fact that the value of the bagasse for fuel at the sugar factory exceeded the price which industry could afford to offer. The writer's experience with by-product utilization has satisfied him that the function of the State or Federal Experiment Station in such developments should be only to supply the fundamental scientific information, leaving the details of practical utilization entirely to the interested industries.

The utilization of agricultural products for industrial uses (the so-called "chemurgy" movement) has been a subject of much discussion in the United States during recent years. "Chermurgy" and "chemurgic" are words coined to indicate the utilization of agricultural raw materials for the manufacture of chemical products (such as cellulose, alcohol, plastics, synthetic fibres, etc.) as contrasted with the customary employment of such raw materials for the production of food, beverages, natural fibres, etc. The enthusiastic advocates of "chemurgy" have even claimed that the supplying of raw materials for chemical products is destined to be the main objective of agriculture, in which event the production of food commodities, etc., will be only of secondary importance. The over-emphasis of this doctrine has unfortunately diverted attention from the more important fundamental problems of agriculture, that relate to soils, crops and livestock, to questions of purely industrial significance. Industry should be allowed to work out its own problems for the solution of which its more specially trained scientists and engineers are the best equipped. The benefit which agriculture is supposed to derive from the industrial utilization of its products is often illusory, as one branch of husbandry is benefitted at the expense of another. The manufacture, for example, of synthetic fibres from bagasse might possibly benefit the sugar planter, but works an injury to the grower of cotton in limiting the demand for his product.

The work of the U.S. Department of Agriculture in sugar cane technology owes its greatest expansion to Dr. H. W. WILEY. During his long connexion with the Department as Chief of its Bureau of Chemistry from 1883 to 1912, his investigations included such subjects as the effect of environment on the composition of sugar-producing crops, applications of the diffusion process to the sugar cane and sorghum, annual surveys of the beet sugar industry,

[1] *J. Amer. Chem. Soc.*, 1904., **26**, p 1221.

improvements in methods of analysis for sugar products, and the establishment of standards for preventing the adulteration of sugar products. Through his work and that of his associates, Dr. G. L. SPENCER, C. A. CRAMPTON, WALTER MAXWELL, A. H. BRYAN and others, Dr. WILEY was the most influential figure of his time in promoting the sugar industry of the United States. The outbreak of an epidemic of yellow fever in New Orleans caused the writer to accept in 1906 the position, just vacated by Dr. G. L. SPENCER, of Chief of the Sugar Laboratory of the U.S. Bureau of Chemistry, under Dr. WILEY. Previous to beginning work in this new position, the writer attended the meeting of sugar chemists at the Congress of Pure and Applied Chemistry in Rome in April, 1906, where acquaintances were formed with H. PELLET, K. ANDRLIK, E. BARBET, H. CLAASSEN, F. DUPONT, F. SACHS, J. STOKLASA, V. VILLAVECCHIA. and other eminent European sugar beet and sugar cane technologists.

Dr. WILEY'S Pure Food Law went into effect in 1906, and much of the writer's attention at this time was devoted to the improvement of methods for detecting the adulteration of honeys, syrups and other sugar-containing products. The natural contamination of Hawaiian honeys with the dextrorotating honey-dew gathered by bees from the exudations of the cane leaf-hopper and cane aphis was a problem that necessitated a long investigation.[1] An effort was made to establish standards of composition for differentiating between table molasses and "blackstrap," difficult to establish because of its varying composition. Inspectional evidence has thus far proved more efficacious than chemical analysis for detecting these forms of adulteration.

Following the recommendations of Dr. WILEY, in 1907, the buyers and sellers of the New York Sugar Trade took joint action in formulating plans for controlling the accuracy of the polarizations of the raw cane sugars that were sold to the refineries of the Atlantic seaboard. The writer was chosen to establish and operate a chemical laboratory for this purpose. Numerous practical problems such as the establishment of a constant temperature laboratory for polarization,[2] the deterioration of sugars and molasses in storage,[3] and the improvement of methods for sugar analysis, awaited attention. The principle adopted at the commencement of the laboratory in maintaining a balance of analytical errors,[4] so that neither buyer nor seller obtained a one-sided advantage, won the confidence of both parties of the Sugar Trade, and its members were most loyal in supporting the laboratory's operations. Frequent contact in New York with such prominent sugar technologists as HENRY NIESE, G. L. SPENCER, SAMUEL C. HOOKER, A. H. BRYAN, F. G. WIECHMANN, NOËL DEERR and W. D. HORNE, was a stimulus to productive accomplishments. The opportunity of meeting the eminent European sugar technologists, H. C. PRINSEN GEERLIGS, M. G. WAGENAAR HUMMELINCK, A. HERZFELD, E. SAILLARD, F. STROHMER, A. AULARD and others, who attended the meeting of the International Commission for Uniform Methods of Sugar Analysis in New York in 1912 was an inspiration to all American sugar chemists.

In 1923, I very regretfully resigned my position with the New York Sugar Trade Laboratory to accept an appointment as Chief of the Bureau of Chemistry, Washington.

I would summarize my 50 years of experience as follows: 18 were spent in Government service, 18 in commercial work, 11 in State experiment station duties, and 3 years in foreign study and travel. As a result of my personal observations, I have come to the conclusion that the agricultural technology of sugar production offers to an energetic young man one of the most attractive fields for a well-balanced career. A sugar plantation, whether for cane or beet, presents so many interesting opportunities in the field, laboratory and factory, that one's occupation never becomes monotonous; it is attended by the constant variety which has been well termed "the spice of life."

In conclusion I can do no better than paraphrase a passage from the final paragraph of my address before the Sixth Congress of the International Society of Sugar Cane Technologists at Baton Rouge on October 31st, 1938[5]: "We need have no fear as to the future ability of our sugar specialists in solving the problems of plant-breeding, cultivation, fertilization, pest control, manufacture, etc., as the needs for such investigations arise. The success of our industry depends not only on such endeavours but also on our ability to co-ordinate all these activities with one another and at the same time to adapt them to the economic needs of each state or nation. If our accomplishments in this direction are supplemented by wise statesmanship on the part of our legislators the future prosperity of our sugar industries is definitely assured."

FRENCH SUGAR ALLOTMENT.—It leaked out at Vichy a month ago that an exchange of food had been effected between occupied and unoccupied France which suggested that France was not so short of food as Vichy propaganda made out. The occupied zone was to send the unoccupied one 800,000 tons of wheat, 200,000 tons of sugar, and a large quantity of bran and potatoes, all in exchange for cattle, small livestock, oil, salt, vegetables, cheese, and a large quantity of wine. The wheat, incidentally, had been released by the Germans from supplies previously requisitioned in France. The sugar is only about 20 per cent. of France's normal consumption, but is obviously a larger proportion for the less dense population of southern France.

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1 *Bulletin* 110, *Bureau of Chemistry, U.S. Dept. Agriculture*, pp. 52-56, (1908).
2 *Communications, Eighth International Congress of Applied Chemistry*, p. 519 (1912).
3 *J. Ind. and Chem.*, 1918, 10, p. 178; *Proc. Fifth Congress, Inter. Soc. Sugar Cane Technologists, Brisbane*, pp. 216-227 (1935).
4 *Louisiana Planter*, 1915, 54, pp. 26-30.
5 *Proc. Sixth Congress Inter. Soc. Sugar Cane Technologists, Baton Rouge*, p. 69 (1938).

Steam-Jet Vacuum Pumps.[1]

By R. E. HELLMER.

It is the purpose of this paper to deal with the characteristics and advantages as well as the limitations of steam-jet vacuum pumps. We propose to analyze the effect of steam pressure, back pressure of operating in single and multiple stages according to vacuum requirements, on the performance of such units. The inter-relation of some of these factors may not yet be fully appreciated by the operating engineer and a discussion of their influence on the design and selection of suitable apparatus for a specific duty is quite interesting.

(1) *Essential Differences between Reciprocating Vacuum Pumps and Ejectors.*—Besides the great difference in physical dimensions between the two types, and besides the facts that the steam jet ejector requires no floor space, no foundation, and has no moving parts or stuffing boxes necessitating more or less constant attention, there are other differences affecting their performance.

The volumetric efficiency of reciprocating vacuum pumps decreases with higher vacua rapidly, whereas ejectors designed for a specific vacuum operate at maximum efficiency at the point. This means, however, that a steam-jet machine intended to operate at, say, 27 in. vacuum and designed for this specific condition operates relatively inefficiently at low vacua. This is why, when priming a container to a certain vacuum, say 27 in.. it will be found that the mechanical vacuum pump does it in less time than an ejector having the same removal capacity at 27 in.

Whenever rapid priming is essential, an auxiliary steam-jet exhauster designed for low vacuum operation should be provided to supplement the ejector used for normal operation under high vacuum. Of course, in a mechanical vacuum pump a considerable portion of the operating power is absorbed in mechanical friction. An increase in size does not represent a directly proportional increase in power. This is not the case with steam ejectors where the steam consumption varies directly with the pounds of air handled.

(2) *Selection of Single and Multiple-Stage Ejectors according to Vacuum Requirements.* — For most economic operation a single-stage ejector can only achieve a limited compression range. Generally speaking, single-stage installations are not used for vacua above 26 in. For higher vacua up to about 29·5 in. two ejectors are installed in series, each one performing partial compression of the air and gases. In most cases the steam from the high vacuum exhauster performing the initial compression is condensed between stages by means of a suitable apparatus, either a jet or a surface inter-condenser, before the air-vapour mixture is delivered to the second so-called low vacuum exhauster for final compression to atmosphere.

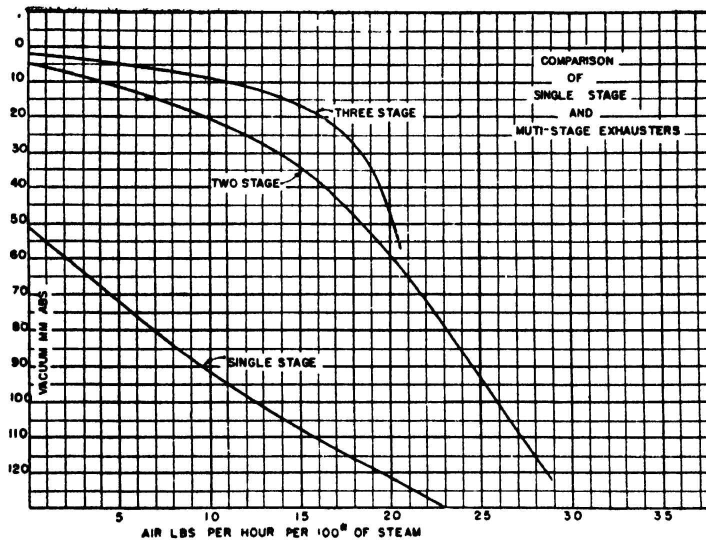

Fig. 1.

In some instances, mostly for very small capacities or where the steam consumption is immaterial or no cooling water available, the 2-stage exhausters are installed without inter-condensers and are called 2-stage non-condensing vacuum pumps. However, this arrangement increases the total steam consumption approximately 75 per cent. due to the fact that the low vacuum exhauster has to handle the steam from the high vacuum exhauster in addition to the air and non-condensible gases. Such an arrangement is entirely permissible where exhaust steam is needed for heating purposes and the air and gases present are not objectionable.

For vacua above 29·5 in., exhausters are used in three stages with suitable inter-condensers and for extremely high vacua four stages are used with two exhausters in series for the initial compression. However, the process industries and particularly

[1] *Proc. 13th Conf. Assoc. Cane Sugar Tech. Cuba*, pp. 63-69.

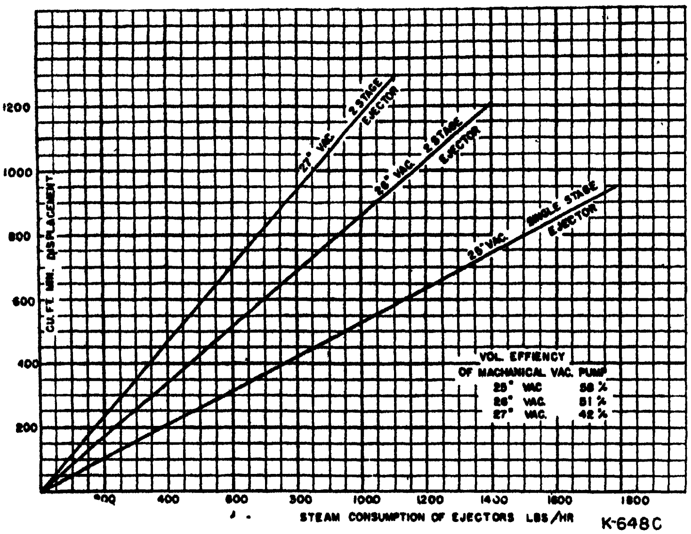

Fig. 2.

sugar refineries do not use vacua above 27 or 28 in. except for cooling syrups.

(3) *Effect of Steam Pressure on the Economy of Ejectors.*—The operating steam pressure, particularly in the low ranges below say 100 lb. gauge has considerable effect on the steam consumption of ejectors for a given air handling capacity. For instance, with 75 lb. gauge pressure the steam consumption will be about 15 per cent. greater than with 100 lb., and with 60 lb. the increase would be 30 per cent. On the other hand, the reduction in steam consumption with pressures above 100 lb. is rather slow, and above say 200 lb. gauge the gain in economy is but very small.

Quite essential for stable and economic operation of ejectors is the elimination of moisture in steam. In other words, provision should be made with every ejector installation to deliver the steam either dry saturated or slightly superheated to the steam nozzles. It is, therefore, recommended to install an efficient steam separator close to every ejector unless the user can ascertain beforehand that the steam used is actually dry or superheated.

Moisture, even a small percentage in the steam, is particularly objectionable in exhausters of small capacities where the steam nozzle has a throat of such a small diameter that even the least particles of moisture will cause instability of vacuum.

(4) *Effect of Back Pressure on their Operation.*—Normally ejectors are designed and operated with atmospheric exhaust. In other words, the low vacuum exhauster discharges the steam and non-condensibles into the atmosphere; or, if the heat content of the steam is to be recovered, an after-condenser of the jet or surface type is provided and vented to atmosphere.

There are instances, however, when it is desired to exhaust against a back pressure above atmosphere, usually for heating purposes. Ejectors have to be specially designed for such duty and the user should be informed that the steam consumption goes up rapidly with the increase in back pressure. Generally speaking, a back pressure above 5 lb. gauge is not recommended because above this value the steam consumption becomes almost prohibitive.

The following table gives an idea of the relation between steam consumption and back pressure, showing the increase in steam consumption with stage exhauster back pressures from 2 to 10 lb. gauge :—

Back Pressure lbs. gauge		Per cent. increase
2	..	8
4	..	22
6	..	42
8	..	80
10	..	300

(5) *Effect of Saturation of Air and Non-Condensible Gases.*—In most processes where non-condensible gases are removed under vacuum these gases as well as the air are saturated with water vapours according to vacuum and temperature. It is, therefore, essential

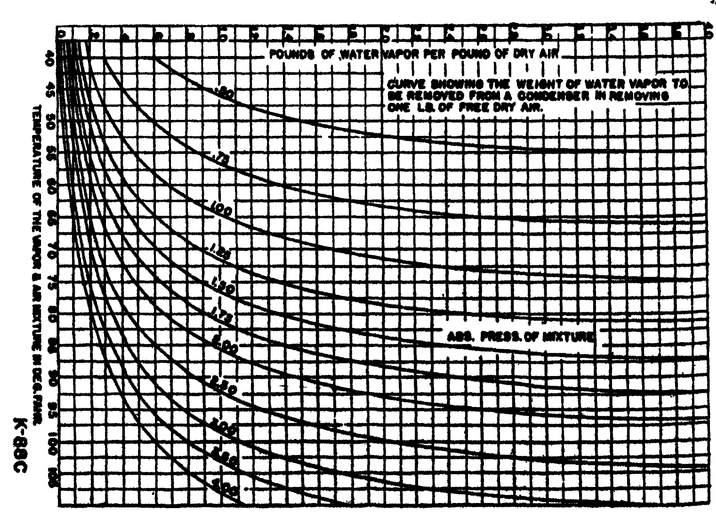

Fig. 3.

to give proper consideration to this condition when estimating the size and capacity of an ejector for a given amount of dry air, as the weight to be actually removed will be determined by the vacuum and saturation temperature.

For instance, 1 lb. of dry air removed from a barometric condenser under a vacuum of 27 in. and a temperature of 95°F. will contain practically 0·8 lb. of water vapour. This means that the ejector has to remove not 1 lb. of air, but 1·8 lb. of saturated air-vapour mixture. It is sometimes possible to reduce this amount by using a so-called pre-cooler, provided water is available at a lower temperature of the air-vapour mixture at the specified vacuum.

Curve sheet K-545-C (Fig. 1) gives an interesting comparison of the capacity and vacuum performance of single and multi-stage exhausters having the same steam consumption, while K-648-C (Fig. 2) illustrates the consumption of single and 2-stage steam-jet air pumps in relation to the capacity of mechanical vacuum pumps expressed in cubic feet per minute displacement. The steam consumption of ejectors is based on the actual air handling capacity of mechanical vacuum pumps derived from the volumetric efficiencies for various vacua as shown on the curve sheet.

Curve sheet K-88-C (Fig. 3) illustrates clearly the ratios of water vapour per pound of dry air to be handled at various vacua and temperatures.

Manufacture of Absolute Alcohol

Using Ether as Entrainer.[1]

By D. F. OTHMER and T. O. WENTWORTH.

At the turn of the century YOUNG[2] developed a method for the manufacture of absolute alcohol which may be regarded as the forerunner of modern azeotropic distillation. This was a batch process, and was patented and used (in Germany, at least, up to the time of the first World War) in about its original form.

KEYES[3] gave a history of the azeotropic method, and showed that Americans actually operated its first continuous industrial application. Since that time many have worked to improve it and make it more economical. Other entraining agents than the benzene used by YOUNG have been tried, and additional columns have been added to make continuously the separations otherwise made in batch units. Further, KLAR[4] has surveyed the literature up to 1937. Of the many improvements in technique applied to the dehydration process, one relates to vapour re-use, patented by WENTWORTH,[5] and described by OTHMER,[6] which results in considerable heat economy.

Most dehydration operations have involved the use of liquids which form with water an azeotropic mixture due to the additive effect of vapour pressures of immiscible liquids. This should be carefully distinguished from the more usual type of constant boiling mixture (c.b.m.) such as that formed by alcohol and water themselves. This latter type of c.b.m. is not due to additive vapour pressures. A liquid added to form an azeotropic mixture with water to reduce its effective boiling point is usually called an "entrainer" or "withdrawing agent."

BENZENE AS ENTRAINER.

Fig. 1 illustrates the vapour pressure curves for water, benzene and water plus benzene. The latter curve is drawn by graphically adding the first two, and intersects the normal atmospheric pressure abscissa at 69°C. (156·2°F.), which is thus the boiling point for a mixture of the two. The effective b.pt. of water has thus been reduced by 31°C. (55·8°F.) from 100 to 69°C. (212 to 156·2°F.), where it is over 9°C. (16·2°F.) lower than the b.pt. of pure alcohol or of the c.b.m. of alcohol and water.

Thus it would be expected that this 9°C. difference between the b.pt. of alcohol, and the effective b.pt of water would allow the water to be rectified out of the mixture. Unfortunately, the simple addition of partial pressures is not all that is involved, since alcohol itself forms a c.b.m. with benzene and a ternary mixture with benzene and water. This ternary system has a composition of about 18·5 per cent. alcohol, 7·4 water and 74·1 benzene; its b.pt., however, is 64·8°C. (148·7°F.) rather than 69°C. (156·2°F.), that of the benzene-water azeotropic mixture. Thus although the b.pt. of the water is reduced it may not be brought over the top of the column without more than twice as much alcohol coming with it.

After condensation, the benzene - alcohol - water ternary mixture consists of two very insoluble liquids (water and benzene) which form a lower layer and an upper one, and a third liquid (alcohol) which is soluble in each layer, and tends to bring both into a common solution. If properly rectified in an efficient column

1 Extracted from *Ind. & Eng. Chem.*, 1940, **32**, No. 12, pp. 1588-1593.
2 German Patent No. 142,502 (of 1903).
3 *Ind. & Eng. Chem.*, 1929, **21**, p. 998.
4 "Fabrikation von absolutem Alkohol" 2nd edition (Knapp, Halle a. Saale), 1937.
5 U.S. Patent No. 2,152,164 (of 1939).
6 *Ind. & Eng. Chem.*, 1936, **28**, p. 1435.

with ample reflux the ternary mixture may be obtained at the head of the column, condensed and separated into two layers. It is necessary to pass the water layer to another column still for the condensation of the alcohol up to a strength where it may be fed back to the azeotropic process. Thus no water is eliminated as such from the azeotropic system, but goes out as a fairly strong alcohol solution. The decantation of the condensate and the subsequent separation of the components of the two layers have been the basic steps of the several dehydration processes.

These processes have utilized other entraining agents than benzene. For example, the "Drawinol" process[1] uses chlorinated hydrocarbons, as tri-

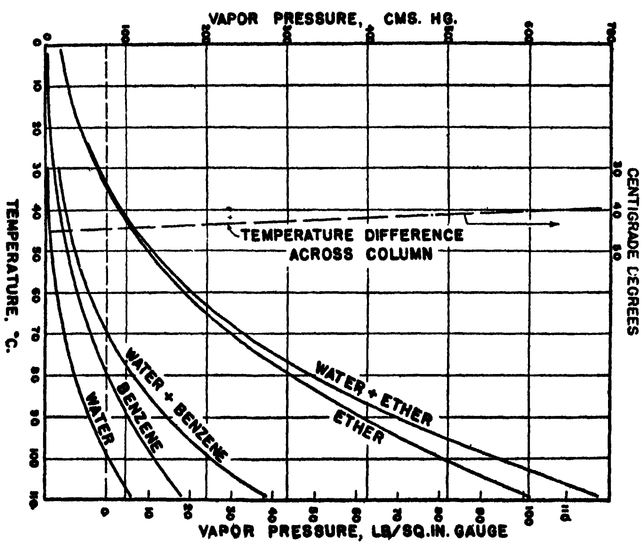

Fig. 1.

chlorethylene, all of which have the same disadvantage as has benzene, i.e., of forming ternary mixtures with alcohol and water together. Search has been made to find a liquid which would give an azeotropic mixture with water, caused by the additive partial pressures or steam distillation effect, but would have no binary c.b.m. with alcohol, and therefore no ternary c.b.m. with alcohol and water. Such a liquid would enable the separation of water from the alcohol at the base without bringing alcohol over the top of the column at the same time.

Ethyl Ether as Entrainer.

Recently one of the authors[2] found that ethyl ether is such a liquid. It has long been known that it forms no c.b.m. with alcohol but steam distils with water at 760 m. and 34·15°C. (93·47°F.), which is over 65°C. (117°F.) lower than the boiling point of water, and almost 45°C. (81°F.) lower than the b.pt. of alcohol. This azeotropic mixture has a composition of 98·75 per cent. ether and 1·25 per cent. water (by weight) at atmospheric pressure. In the practical application of an azeotropic distillation process, the entrainer brings over the water which after condensation is decanted.

Following condensation of an azeotropic mixture of this sort, the condensate is decanted into two layers. Because of the small size of the water layer, the solubility of ether in water is not important, although the solubility of water in the ether layer is of prime importance. The lowest practicable temperature in the decanter would be desirable to minimize the amount of water returned to the column due to its solubility in the ether-layer reflux.

Equipment.

A dehydrating unit utilizing this system would have a temperature at the top corresponding to the temperature of the water + ether curve in Fig. 1 at the operating pressure employed. If there is pure alcohol in the still pot, and if the pressure drop across the column is neglected, the temperature in the pot will correspond to the boiling temperature of absolute alcohol at the vapour pressure equivalent to the operating pressure. Thus if the vapour pressure curve of alcohol were plotted on a graph similar to Fig 1, the horizontal distance along the abscissa at any given pressure between the corresponding temperature of water + ether and the temperature of alcohol at the same vapour pressure would give the number of degrees of temperature difference between the top and the bottom of the column.

In Fig. 1 this relation of the temperature difference across the column is plotted against the corresponding vapour pressures, using the temperature scale at the top. There is a slightly lower temperature difference across the column at higher than at lower pressures. This function may be used to indicate the relative ease of separating the pure alcohol at the bottom of the column from the azeotropic mixture of ether and water at the top, since, in general, the temperature difference across the column indicates roughly the relative ease of separation of the components of the mixture being distilled.

Table I indicates the number of plates required for the dehydrating process using ether as well as the number required in the dehydrating column of a modern and efficient system of the usual type having a ternary c.b.m. with alcohol and water, using benzene as an azeotropic agent. While the benzene system requires 50 plates the ether process requires only 30. The column required for stripping the water layer free of benzene after decantation and before re-concentrating has 30 plates, as compared to a maximum of only

[1] *I.S.J.*, 1933, pp. 29, 71, 146.

[2] U.S. Patent No. 2,152,164 (of 1939).

Table I: Comparison of Methods.

Process and Method of Operation.	Feed Concn. Vol. per cent. Alcohol.	Plates required in— Exhausting column (beer still).	Purifying column.	Recti-fying column.	Dehy-drating column.	Water-layer stripping column.	Supplementary rectifying col. (dehy-dration unit).	Steam* Consumption. Lbs./gall. of feed.	Lbs./gall. of product.
Continuous exhaustion and rectification to produce crude 96% alc. (vol.)....	6·25	20	Not required	30†	—	—	—	1·30	20
Continuous exhaustion, purification and rectification to produce refined 96% alc. (neutral spirits); Barbet system	6·25	20	30	54‡	—	—	—	2·21	34
Ditto, using the vapour re-use system..	6·25	20	45	54‡	—	—	—	1·30	20
Continuous dehydration of refined 96% alc.; benzene system at atm. pressure	96·00	—	—	—	50	30	45‡	8·16	8·5
Continuous exhaustion, purification, rectification and dehydration to produce refined anhydrous alcohol; Barbet system + benzene dehydration	6·25	20	30	54‡	50	30	45‡§	2·74	43·9
Ditto, using the vapour re-use system with other dehydration at 125 lbs. per sq. in.	6·25	20	45	54‡	30	20	Not required	1·31	21

* Calculations based on appropriate heat interchanging in each instance. † Enriching section only. ‡ Enriching and exhausting section. § The main rectifying column may be used for concentrating aqueous alcohol from the stripping column, provided sufficient excess capacity is present.

20 for the easier separation of dissolved ether from the corresponding water layer.

In addition, the benzene system requires for concentrating the water layer after stripping of benzene a supplementary column still of some 45 plates; but no such still is required for the ether process. While the sums of the number of plates required (125 for the benzene and 50 for the ether process) are meaningless in themselves, they do indicate the relative complications and cost of equipment, controls, and operation for the two processes. Besides requiring smaller and less efficient equipment, this ether process uses the theoretical minimum number of pieces of equipment for any azeotropic process i.e., a main azeotropic column still, a second stripping still, a single condenser, and a decanter, together with the rotary pumps, etc. The vapour re-use system[1] may readily be applied to this process in a modified form to give low steam costs. Table 1 lists these costs under various conditions.

Economies Effected.

This ether dehydrating process in combination with other methods demonstrated by years of economical operation with proved savings makes possible the production of a refined anhydrous alcohol at an over-all steam cost from the dilute distiller's beer of 21 lbs. per gallon. This is only 1 lb. of steam per gallon more than the usual practice for producing a crude 96 per cent. alcohol, and less than half as much as is required for producing a comparable product by other standard methods in use.

Alcohol made by this system for all practical and scientific purposes is entirely free of ether, i.e., not more than a few parts per million, and is rigorously anhydrous, since the water is entirely removed at a higher level in the column than the ether. This practically perfect separation is possible because of the very large temperature differences (*a*) between the b.pt. of the azeotropic mixture, ether-water, and that of alcohol; and (*b*) between the boiling point of the azeotropic mixture of ether-water and that of water, as compared to the respective b.pt. differences for systems using benzene, trichlorethylene, etc.

Advantages.

This process has been tried and proved by the operation of a pilot plant over an extended period of time, and a number of advantages have been demonstrated, which may be summarized here as follows: Alcohol-free water and water-free alcohol are easily produced in one column. All of the alcohol entering the azeotropic rectifying column as feed is delivered directly as anhydrous or absolute alcohol from the base. All of the water is withdrawn from the top of the column free of alcohol in the form of the c.b.m. with ether, and is discharged from the base of the water-layer stripping column free of both alcohol and ether.

Lower steam and water consumption is required in conjunction with the preliminary distillation operations than is required by any of the existing dehydrating processes, including those which employ ternary azeotropes. Comparatively small and simple equipment is necessary owing to the absence of a ternary c.b.m. and to the wide difference in b pts. between the ether-water azeotropic mixture and alcohol, and the ether-water azeotropic mixture and water. The added economy of the vapour re-use process or related systems is readily adaptable to this process. It is simple to operate and can be made fully automatic.

1 Wentworth and Othmer, *ibid.*

Chemical Reports and Laboratory Methods.

Determination of Reducing Sugars, using the Munson and Walker Gravimetric and the Permanganate Volumetric Methods. M. García Hernández and César Form. *Proc. 13th Conf. Assoc. Sugar Tech. Cuba*, pp. 199-202. In the following table, the figures for reducing sugars given for final molasses and invert syrups under (*A*) are those reported by the New York Sugar Trade Laboratory using the M. & W. gravimetric procedure; while those under (*B*) are those obtained by the senior author using the $KMnO_4$ volumetric method, operated on the same samples.

FINAL MOLASSES.

	(*A*)	(*B*)	(*C*)		(*A*)	(*B*)	(*C*)
1	20·39	20·30	—0·09	12	18·53	18·67	0·14
2	20·35	20·60	0·25	13	21·57	21·72	0·15
3	20·99	20·88	—0·11	14	19·53	19·39	—0·14
4	18·96	19·52	0·56	15	13·40	13·24	—0.16
5	25·39	24·76	—0·63	16	17·31	17·15	—0·16
6	18·99	18·52	—0·47	17	24·43	24·54	0·11
7	20·71	21·07	0·36	18	25·64	25·52	—0·12
8	19·84	20·10	0·26	19	19·96	20·04	0·08
9	21·25	21·20	—0·25	20	19·55	19·61	0·06
10	26·11	25·73	—0·38		——	——	
11	20·01	20·21	0·20	Avg.	20·65	20·70	

INVERT SYRUPS.

	(*A*)	(*B*)	(*C*)
1	54·00	53·27	—0·73
2	50·49	51·00	0·51
3	51·26	51·48	0·22
4	50·43	50·45	0·02
	——	——	
Average	51·54	51·55	

Thus, a good agreement was obtained by the two methods, but the permanganate is the more rapid as in it the time required for the titration of the reduced Cu_2O does not require more than five minutes, as compared with the longer time taken in the other method for the reduction of the oxide to metallic copper, its cooling and its weighing. Details of the permanganate method preferred by the authors are given below, these differing a little from those specified by the A.O.A.C.[1]

Standardizing.—Oxalic acid is not used, as it is said to give very low values. Instead, 0·3 grm. of sodium oxalate is dissolved in 250 ml. of water at 80 to 90°C. in a 400 ml. beaker, and mixed with 10 ml. of sulphuric acid (1 : 1); then N/10 potassium permanganate solution is added from a burette, until, while stirring vigorously, a pink colour persists for some 15 secs., the addition being made at a rate not faster than 10 to 15 ml. per min., with the last 0·5 ml. in drops. If the $KMnO_4$ solution is exactly N/10, 44·8 ml. will have been used for the 0·3 grm. of oxalate.

Determination.—First, 0·4 grm. of the 1 : 1 molasses or syrup is weighed out into a 100 ml. flask, defecated with neutral lead acetate, filtered, de-leaded with dry sodium oxalate, kieselguhr added, and again filtered. Next, 25 ml. of Soxhlet *A*-solution is mixed with the same volume of *B*-solution in a 300 ml. Phillips flask, and 25 ml. of water and 25 ml. of the de-leaded molasses solution added.

This mixture is heated so that boiling begins in 4 min., ebullition being continued for exactly 2 min. longer; following which it is immediately filtered through a 25 ml. Caldwell crucible (prepared with a ½ in. layer of asbestos), using vacuum. The Cu_2O is thoroughly washed with water at 60°C., after which the bottom of the crucible is pushed into the Phillips flask, and 25 ml. of hot ferric sulphate solution (200 grms. $Fe_2(SO_4)_3 . 9H_2O$ in 1000 ml. of water containing 20 per cent. of sulphuric acid) added to the flask through the crucible.

After shaking the contents of the flask well so as to completely dissolve the Cu_2O, 100 ml. of hot water is added, the liquid being finally titrated with the N/10 permanganate solution. Then the ml. of $KMnO_4$ used to produce a pink coloration × 6·36 gives the mgrms. of reduced copper; on reference to the M. & W. Table[2] the corresponding amount of reducing sugars is obtained. This figure × 2 gives the result required.

Grub Fumigants and Poisons so far tried. R. W. Mungomery and J. H. Buzacott.[3] *Cane Growers' Quarterly Bulletin*, 1940, **8**, pp. 57-59.—*Inorganic*: Arsenic compounds, barium chloride and sulphocarbonate, calcium carbide, copper carbonate and sulphate, cyanides, *K* di-nitro-ortho-cresylate, sulphur, sulphur monochloride, spent liquors from gas works, and zanthates. *Organic*: Acetone, amyl alcohol and acetate, benzaldehyde, benzene and benzene chlorinated and nitrated compounds, benzyl chloride, carbon disulphide and tetrachloride, chloropicrin, creosote, epichlorhydrin, dichlorethyl ether, ethylene chlorhydrin, tetrachlorethane, ethylene di- and trichloride, hexene, propylene compounds, mustard oil. *Proprietory*: Ammoncent, Arresto, Carbolinium, Carbosyl, Chloroside *A* and *B*, Creolin, Eulan-*B*, Encectol, Florium, Globol, Jeyes' Soil Cleanser, Kill-a-Mite, London Purple, Paris Green, Phenyle, Schweinfurt, Vaporite, Vermorite, Zanthate. *Mixtures*: Benzene + creosote or + sinapis oil or + naphthalene or + para-dichlorbenzene; carbon disulphide + creosote or + benzol or + para-dichlorbenzene or + orthodichlorbenzene or + kerosene or + mustard oil or + turpentine; kerosene + pyrethrum and naphthalene + isnap-oil. *Some results*: Soluble arsenic compounds cannot be used, being so very poisonous

1 "Methods of Analysis of the Association of Official Agricultural Chemists" (5th Edition), p. 501. 2 "Handbook for Cane Sugar Manufacturers and their Chemists." - Spencer-Meade. Table 44.
3 Entomologist and Assistant Entomologist of the Bureau of Sugar Experiment Stations, Brisbane.

to plant life; with white arsenic the best kill was only 70 per cent. with 200 lbs. per acre; lead arsenate mixed with the soil is too expensive. CS_2 is a fumigant which gives a good kill under most conditions, and a better one when mixed with o- and p-dichlorbenzene. $Ca(CN)_2$ used in granular form as "Cyanogas" was found unsatisfactory. Ethylene and propylene dichlor both gave poor results.

Action of Bases and Salts on Sucrose. J. DUBOURG and R. SAUNIER. *J. Fabr. Sucre*, **78,** pp. 412-414; through *Chem. Abs.*, 1940, **34,** 3526.—The previously observed effect of the alkalis and alkaline earths on the rotary power of sucrose (usually a decrease in rotation) is attributed to a change in the hydration of the sucrose in the solution brought about by the alkalis. The cations sodium, potassium and calcium, which are hydrated in solution alone, reduce the hydration of the sucrose and thus favour the dissociation of H ions from it and subsequent salt formation. Increasing the alkali concentration sharply reduces the rotation. Correspondingly ammonia does not reduce the amount of rotation, as it itself is not hydrolyzed. Alcohol is without effect in neutral solution, reduces the rotation in alkali solution and increases it in ammoniacal solution. As a result of hydrolysis, alkali salts of weak acids effect the rotation more strongly than those of strong acids. The decrease in the degree of rotation by salts is greater in alkali than in neutral solution. The reduction of the rotational power of sucrose by anions was studied by the use of the sulphite ion.

Report on Methods for detecting and estimating Number of Thermophilic Bacteria in Sugar. E. J. CAMERON.[1] *Journal of the A.O.A.C.*, 1940, **23,** pp. 608-613. — Previous reports on microbiological methods for sugars have been published,[2] and indicate the technique of examination and the media used in enumerating three thermophilic groups of organisms that are important in the spoilage of canned foods. The present report deals principally with a description of collaborative tests of the methods already described. In the main, attention has been given to the aerobic sporing types, namely the total spore count, and the "flat sour" count. The test sugars which were used carried some degree of contamination by the other important groups, the sulphide spoilage organisms and the thermophilic anaerobes, and therefore opportunity was given to test the media for these groups.

Rapid Determination of Water in Soils. J. E. COKE. *Sugar Beet Bulletin*, 1940, **4,** pp. 24-25.—To use the standard method of drying means that information as to the amount of available water in a grower's field may arrive too late to be of value, especially in irrigation control. A method developed at the Michigan Agricultural Experiment Station consisted in pouring 20 to 30 c.c. of alcohol over 20 grms. of the soil, burning off the alcohol, and re-weighing, the loss of weight being taken to be the water content of the sample. In this way a determination can be made in 10 to 15 min. A kit has been provided for use in the field. A single determination of the water in a soil is seldom of value. It is the trend of the movement of the water in the soil that is significant, and such records have been charted by the Spreckels Sugar Co. so that the extraction of the water from the soil can be visualized as a whole. In any case frequent water determinations are necessary for proper irrigation practice. ✓

Chemical Innovations. ANON. *The Laboratory*, 1940, **12,** pp. 29-47. — Among those described are the following: A rough balance, capacity 5 kg., sensitivity 1 grm., with a sliding weight for counterpoising the container, the weight of the material weighed out being indicated on a dial. A Liebig condenser having brass inlet and outlet tubes mounted in moulded soft rubber "couplers" making a flexible seal between the jacket and the inner tube, also between the brass water connexion and the jacket, a shock-proof arrangement being thus provided which possesses other distinct advantages. A Petri dish, the approach to which for making inoculations is through the small opening provided by the contiguity of two slots, one in the side of the bottom of the dish, and the other in the side of the lid, the danger of contamination being thus reduced. Pyrex "fritted" ware, i.e., Gooch and Buchner type crucibles and filter tubes provided with discs of porous material serving as the filtering medium, this replacing the German Jena devices.

Report of the New York Sugar Trade Laboratory. F. W. ZERBAN. Issued by the Laboratory, 113, Pearl Street, New York.—The total number of raw sugar samples polarized for buyers and sellers was 16,840, the highest figure since 1932. The average polarization of all samples has increased from 97·20 in 1939 to 97·23 in 1940. The percentage of samples testing 98 and over was slightly smaller in 1940 (13·81) than in the previous year (14·84); most of these samples represented Australian, Hawaiian, and Philippine raw sugars. The proportion of sugars testing from 97 to 98 was the highest in the history of the Laboratory, 54·20 per cent. That of samples between 96 and 97 polarization was slightly smaller in 1940 (27·41 per cent.) than in 1939 (27·96 per cent.), while that of samples in the 95 to 96 group has fallen from 4·95 per cent. in 1939 to 3·47 per cent. in 1940. The percentage of samples testing less than 95 was only 1·12 in 1940, against 1·33 in 1939. The average monthly polarization was above 97 in every month of the year 1940, for the first time since the foundation of the Laboratory, and the total spread in the average monthly polarizations

[1] National Canners' Association, Washington, D.C., U.S.A.

[2] *Journal of the A.O.A.C.*, 1936, **19**, p. 438; 1938, **21**, p. 457.

was only from 97·09 to 97·35, the lowest on record. Molasses and syrup samples increased from 666 in 1939 to 958 in 1940, and samples for special determinations amounted to 344.

A New Micro-Calorimeter: Heats of Dilution of Aqueous Solutions of Sucrose. FRANK T. GUCKER, Jr., HUGH B. PICKARD and RALPH W. PLANCK.[1] *Jl. Amer. Chem. Soc.*, **61**, p. 459.—Study of heats of dilution of dilute aqueous solutions requires calorimetric apparatus capable of measuring small temperature changes to a millionth of a degree. Such a micro-calorimeter is described here. It was used to study the heats of dilution of sucrose in aqueous solutions from 0·2 to 0·005m at 20°C., and from 0·2 to 0·0001m at 30°C., which were found to be a linear function of m over the whole range within an average deviation of $\pm$ 3 micro-degrees C. Results are presented in tables and figures, and combined with the results of other workers on more concentrated solutions to obtain equations for the molar relative heat capacities of sucrose and of the water in these solutions.

Chemical Treatment of Timber for Mill Tram-Lines. O. S. DAHL. *Proc. Queensland Soc. Sugar Cane Tech. 11th Conf.*, 1940, pp. 139-146.—Timber decay is due to a white-rot or a brown rot fungus, the former attacking the cellulose and lignin, and the latter the cellulose only. Tar is not a good poison for either fungi or white ants; but provided penetration is both uniform and sufficient creosote oil is a satisfactory preservative, giving good protection from both fungi and termites. A mixture of white arsenic, caustic soda and crude oil is deterrent to termites, but of little use against the fungi attacking wood. In applying the creasote, it may be brushed hot upon the surface of the wood, using several coats, but with very hard wood the penetration seldom exceeds ⅛ in. Cracks or fissures should always be treated with creasote, being very liable to fungoid infection. Creasote may be injected internally into timber by means of pressure grease guns through holes ½ in. diam. Australian ironwood, also known as "poison wood," contains the toxic substance *Erythroploeum*, which with its great hardness are believed to account for its great durability and power of resistance against fungi and termites.

Preparation of Nessler's Reagent. A. P. VANSELOW. *Ind. & Eng. Chem.* (analy. edn.), 1940, **12**, pp. 516-517.—Disconcerting experiences with Nessler's reagent prepared according to formulas found in textbooks and the literature include slowness in the development of colour, formation of a red precipitate, and the development of off-colours, especially with low concentration of ammonia. The author, however, finds these irregularities are avoided when the following formula is used: 45·5 grms. of mercuric iodide and 34·9 grms of potassium iodide are dissolved in as little water as is needed, 112 grms. of potassium hydroxide (140 ml. of an almost saturated solution, sp. gr. $\frac{15^\circ}{4^\circ}$ = 1·538) added, and the whole diluted to 1 litre. This solution is 0·2 N with respect to the mercury content. In the Nessler test, 5 ml. of this reagent to 100 ml. of final volume are used, and the colour comparisons with the standards are made 30 minutes after mixing. Nessler's reagent prepared according to this formula has been used for several years with completely satisfactory results at all times.

Specific Heats of Aqueous Sucrose Solutions. FRANK T. GUCKER and FRED. D. AYRES.[1] *Jl. Amer. Chem. Soc.*, **59**, pp. 447-452.—In the table below are summarized the results of determinations of the specific heat of sucrose solutions at 20°C. as found by several investigators, the authors' present values being given in the 6th column. In the 5th column are given the values for the specific heats calculated from the heat capacities given in the "International Critical Tables," these representing a weighted mean of the early results. They differ from the authors' present results by 1·5 per cent., and are lower for every concentration excepting the last.

Weight, per cent.	m	s(F., B. and H.)[2]	s(J. and A.)[3]	s(I.C.T.)[4]	s(G. and A.)[5]
0	0·0	1·0000	1·0000	1·000	1·0000
	0·1	0·9830			0·9810
5	0·1538			0·966	0·9714
	0·2	0·9633			0·9633
	0·3	0·9452			0·9467
10	0·3247		0·9436	0·930	0·9428
	0·4	0·9305			0·9312
15	0·5157		0·9162	0·902	0·9144
	0·6	0·9032			0·9029
20	0·7306			0·870	0·8861
	0·8	0·8791			0·8776
	1·0	0·8579			0·8551
30	1·2525		0·8320	0·811	0·8299
40	1·9483		0·7770	0·751	0·7744
50	2·9224		0·7110	0·703	0·7213
60	4·3838			0·677	0·6668
65	5·4274		0·6330		0·6406

Microscopic Identification of Sugars and Polyhydric Alcohols. JOHN A. QUENSE and WM. M. DEHN. *Ind. & Eng. Chem.* (analy. edn.), 1940, **12**, pp. 556-560.—Following their previous contribution,[6] the authors contribute further micro-photographs, extending the use of the method to there rare sugars and three polyhydric alcohols and twelve binary mixtures, including sucrose-glucose, glucose-lactose, lactose-raffinose, etc.

[1] Of the North-Western University, Evanston, Ill., U.S.A. [2] Frenzel, Burian and Haas. *Zeitsch. Elektrochem.*, 41, p. 419. [3] Janovsky and Archangelsky. *Zhur. Sakharnoi Prom.*, 2, p. 614; *I.S.J.*, 1931, p. 597. [4] "International Critical Tables," 5, p. 125. [5] Gucker and Ayres in the present paper. They also determined values at 25°C. [6] *I.S.J.*, 1940, p. 110.

Abstracts of the International Society of Sugar Cane Technologists.

Under the scheme initiated by the International Society, a collection of abstracts of papers on agricultural and technical subjects is prepared monthly. A selection from these "Sugar Abstracts" has been made by us from the material last issued, and is printed below.

Cane Agriculture.

Hot Water Treatment of Seed Cane. C. W. Edgerton and I. L. Forbes. *Sugar Bulletin*, 1940, **18**, No. 18, pp. 4–5.

In view of the appearance of the chlorotic streak disease of sugar cane in Louisiana, and the reported success of its control by hot water treatment of the seed pieces in Hawaii, some investigations were made at the Louisiana Experiment Station.

These experiments show that : (1) the hot water treatment apparently destroys all the chlorotic streak ; (2) cane affected with chlorotic streak and not treated sometimes germinates very poorly and the young shoots that are produced often do not develop satisfactorily ; (3) the effect of the hot water treatment on cane free of chlorotic streak disease apparently depends on the weather conditions during the following winter. In some years better stands will be obtained, while in other years the effects will not be so satisfactory.

Treatment with hot water at 52°C. gave the most satisfactory results. A higher temperature seems to injure the cane. The varieties Co 281 and Co 290 are more subject to injury by heat than are the other varieties. A more rapid germination was obtained by seed treatment ; but, in the later plantings especially, this did not result in better stands.

The Synthesis of Sucrose by Excised Blades of Cane. Constance E. Hartt. *Hawaiian Sugar Planters' Record*, 1940, **44**, No. 2, pp. 89-116.

Evidence indicating that the leaf blade of the sugar cane plant can manufacture cane sugar when supplied with the simple sugars, glucose and fructose, was previously presented in a study of the synthesis of sucrose by excised blades of sugar cane.[1] Numerous experiments have been conducted since, all of which show that the blade of the cane plant has a particularly efficient mechanism for the formation of cane sugar from simple sugars. The questions of how soon the formation of sucrose can be detected, how long a detached leaf can continue to carry on the synthesis of sucrose, and how this process is affected by temperature, are considered in this report.

The results of a large series of controlled experiments lead to these conclusions :

Supplying the blades with both glucose and fructose hastens and increases the formation of cane sugar in the dark, compared with supplying only one of the simple sugars.

Detached blades of the sugar cane plant can continue to form sucrose from glucose for nearly two weeks, reaching over 16 per cent. cane sugar on the dry weight basis.

Temperature affects the absorption of simple sugar, the interconversion of glucose and fructose, and the formation of sucrose.

The absorption of simple sugar is much the same at 6 and 20°C., but is increased considerably from 20 to 40°C.

The interconversion of glucose and fructose does not take place at 6°C. ; it keeps pace with the formation of sucrose at 20°C. ; and at 30 to 40°C. it is increased.

The optimum temperature for the formation of sucrose was found to be 30°C.

The temperature coefficients obtained in this investigation suggest that absorption at low temperature (6 to 20°C.) was a purely physical process, but at higher temperatures (20 to 40°C.) absorption was limited by a chemical reaction. The synthesis of sucrose, however, was limited by a chemical reaction at lower temperatures but by a physical process at higher temperatures.

The evidence indicates that the simple sugars are fleeting intermediates in the leaf and that cane sugar is a storage product.

Cane Growth affected by Light as well as Heat. E. W. Brandes and J. I. Lauritzen. Release of U.S. Dept. of Agriculture, September, 1940.

In mountainous country—particularly in the tropical and subtropical climates suitable for sugar cane—sharp contrasts in cloud conditions on opposite sides of a mountain occur frequently, with one side rainy and the other side clear, with clouds lingering over one side of the range and bright sun over the other. Often the contrast in temperature is not so sharp as the contrast in the hours and intensity of sunlight. In some tropical areas the rainy season is generally cloudy, in contrast to other areas where showers are sandwiched between hours of blazing sun.

In greenhouse experiments at Arlington Farm the authors arranged for conditions that resemble what sugar cane may encounter on opposite sides of a mountain range. They grew two lots of canes at 78°C., normal for good growth of cane, and one lot at 60°F., too cool for best growth. One of the lots in the warm greenhouse was grown under moderately intense lighting, the other with reduced light more

[1] *I.S.J.*, 1941, p. 87.

nearly equivalent to cloudy weather. In the cooler greenhouse the light was kept equal to the reduced lighting in the warmer house.

The result was that under full light the cane in the warm house grew thriftily and rapidly. In the cool house the cane remained healthy but made rather slow growth. The third group of canes grown in warmth, but with reduced lighting did not make intermediate growth as might have been anticipated. These canes barely made a start, and many died after a few weeks of weak growth. It became evident that the added warmth was not an aid to these plants, and that, if they lacked full light, the added warmth was actually a handicap. The plants clearly required a balance between light and temperature, and could not endure high temperature with low light intensity.

These experiments help to explain the "over the mountain" problem; they also help to explain other examples of seemingly freakish behaviour. The results are likely to be of practical value to planters in restraining plantings in areas where cloud conditions do not match up with temperature conditions. It may also be possible for the sugar cane breeders to discover varieties less sensitive to a balancing of light and temperature conditions, and thus capable of growing in areas where the light-sensitive varieties will not do well.

Beet Technology.

Utilization of Press-Water from Drying Plants. M. von Lillienskiold. *Zeitsch. Wirtsch. Zuckerind.*, 1940, **90**, No. 1/2.

A further possible method of utilizing the press-water is to convert both the sugar and albumin in it into a high-grade stock feed, using the yeast *Torula utilis* as the fermenting organism. This yeast produces no alcohol; it is able to convert 80 per cent. of the sugar into a concentrated stock feed containing about 50 per cent. of protein.

On the basis of published figures, a plant drying 180 tons of beet tops a day produces enough press-water to make 1,306 metric tons of dried yeast, the value of which much more than covers the cost; and the residual liquor can be discharged into the water courses without further treatment. But the problem is more a mechanical than a chemical one, and search should be made for a method by which the tops may be freed from excess water before they are shredded.

On the Forms of Sugar Crystals. E. Rieger. *Deut. Zuckerind.*, 1940, **65**, No. 35, pp. 585-588.

Variations in crystal form will depend either on the construction of the vacuum pan or on the methods of the boiler, but when refined syrups have a sufficiently low content of ash and lime salts, the design of the pan is not of decisive influence.

There then remains the method of operating. Agglomerates are much favoured if a too small amount (100 grms.) of seed crystals is drawn into the pan. In such a case the boiler thickens the syrup to avoid re-dissolving this small amount of seed, and after graining keeps the mass rather tight for the same reason. Under these conditions, most of the sugar will be in the form of agglomerates and only a small proportion will be as well-formed individual crystals.

Heating the vacuum pan with high-pressure steam to produce a large evaporation rate per unit of heating surface gives a greater percentage of agglomerates than heating with exhaust steam. A low supersaturation and a low velocity of crystallization are the conditions for producing well-formed crystals and a minimum amount of agglomerates. These considerations indicate that the boiler should use a larger amount of seed crystals (powdered sugar) and that ample pan heating surfaces should be provided along with an ample supply of exhaust or low-pressure steam.

Further, conditions leading to agglomerate formation are: With a system of central condensation, the quick cutting-in of a fresh pan may lower the vacuum so as to bring circulation in the other pans to a standstill, and as much as 80 per cent. of agglomerates may be formed. Use of steam injectors to keep up circulation may help.

If the central condensation system is too small the syrup draught taken into one pan may stimulate evaporation to such an extent that boiling in the others is directly repressed, with falling vacuum and rising temperature. If this occurs after grain formation, the amount of agglomerates may reach 75 per cent.

If a massecuite has been boiled to a finish and for some reason cannot be immediately discharged, and if too much water or syrup be taken in, or the massecuite becomes so dilute that the crystals sink to the bottom, there will be a 100 per cent. formation of agglomerates.

Action of Activated Carbon on Beet Juices at Different Stages. J. Dedek and D. Ivancenko. *Listy Cukrovar.*, **58**, No. 51-52, pp. 312-317; *Deut. Zuckerind.*, 1940, **65**, p. 631.

Diffusion juice was treated with activated carbon, stirred for 15 min. and filtered. With Carboraffin, the content of all kinds of nitrogen in the juice showed a decrease; the action of the carbon is comparable to that of lime in the defecation process. The effect, as seen in the thin-juice, was proportional to the amount of carbon used. In particular, the subsequent darkening of the first carbonatation juice during the further treatment was diminished by half and the purity of the thin-juice obtained in this way was appreciably higher.

In another experimental series the diffusion juice was treated according to the usual factory processes of pre-defecation, main defecation, and the first, second and third carbonatations to obtain finished thin-juice, which was brought by the final sulphuring to a nearly neutral condition. This juice was then treated with various quantities of activated carbon. As was to be expected, there was an appreciable improvement in the colour. Besides that, there was a decrease in the content of lime salts and of the different forms of nitrogen compounds. Addition of activated carbon to this juice during the evaporation did not produce a further decrease of lime salts, but there was a further appreciable decrease of colour; the total result here was an increase of purity of the thick-juice over that of the thin-juice, which indicates that the carbon has a greater effect in the evaporator than in the thin-juice treatment; hence the evaporator appears to be the best place to use the carbon.

Fires in Stored Dried Beet Pulp and their Avoidance. W. PAAR. *Deut. Zuckerind.*, 1940, **65**, pp. 65-68.

Forty-three cases of fire in the dry pulp warehouses of beet sugar factories are classified according to origin. There were 26 cases of spontaneous combustion; seven cases of ignition by sparks entrained from the drying apparatus; three fires were caused by the lighting equipment; two were arson cases; and one each were due to short circuit and "carelessness." In three cases the cause of the fire could not be ascertained.

Fires from spontaneous combustion are undoubtedly due to insufficient drying of the whole or a part of the mass. If the percentage of moisture in any part has not been reduced to safe limits, the pulp becomes an excellent medium for the growth of bacteria and fungi, and the temperature rises to a point where bursting into flame sometimes occurs with explosive violence.

A moisture content of not more than 14 per cent. is considered a safe limit, but pulp dryers have to reckon with the fact that stored dry pulp absorbs moisture from the air and in time may exceed this limit; hence it is a practice to reduce the moisture content to 8 per cent. or less, so as to give the pulp a longer storage life before it approaches the legal limit.

This, however, brings about another chance for fires. When the material is too sharply dried, small portions may become carbonized and form "pyrophoric charcoal" which avidly absorbs oxygen and ignites spontaneously. This is mostly the cause of pulp fires that are said to originate from "sparks passing through the dryer." These circumstances have given rise to some interesting disputes with insurance companies.

MAURITIUS.—The total output of sugar for the 1940 crop in Mauritius came to 315,570 metric tons, which was a very satisfactory figure, since the first months of the growing season were not favourable. May, June and July, on the other hand, were much above normal and helped to bring the canes forward.

ARGENTINE SUGAR PRODUCTION, 1940.—According to Lamborn, sugar production in Argentina during 1940 reached a new record with 540,374 metric tons, which compares with 521,584 metric tons in the previous year. Distribution for consumption during 1940 was approximately 480,000 tons, as compared with 425,000 tons in 1939. Exports during 1940 came to 44,000 tons, most of the sugar going to Uruguay and Bolivia.

DEATH OF E. O. VON LIPPMANN.—Information has only now reached this country of the death on September 24th of this distinguished German savant. He was for many years technical manager of the Halle a. S. sugar refinery, but his name will long be remembered as the author of several valuable works of an erudite character. Prominent among these are his "Geschichte des Zuckers" (1890, supplement in 1935), and "die Chemie der Zuckerarten" (3rd edition, 1904), which latter is a standard work of reference, kept up to date by the annual reviews which he published in the *Chemiker Zeitung*. He also issued a "Geschichte der Rube"; while his "Geschichte der Wissenschaft" and "Entstehung der Ausbreitung der Alchemie" are regarded as examples of remarkable scholarship. Prof. Dr. E. O. von Lippmann died at the ripe age of 84, as the result of a car accident.

WEST INDIAN SUGAR EXPORTS, 1941.—According to the *West India Committee Circular*, the estimated exports of sugar from the British West Indies during the period from January 1st to August 31st, 1941, are as follows: Barbados, 66,000 tons; Jamaica, 128,790 tons; Trinidad, 106,345 tons; Leeward and Windward Islands, 66,400 tons; British Guiana, 80,978 tons; and British Honduras, 500 tons; a total of 449,013 tons. An additional 27,000 tons will, it is estimated, be exported from Barbados in the form of Fancy Molasses.

EXPORTS FROM PERU.—According to Mr. A. N. Crosby of Lima, the exports of sugar from Peru during 1940 came to 304,216 metric tons telquel, as compared with 267,522 tons in 1939, and 254,823 tons in 1938. The highest export figure of the past five years was in 1936 when 323,123 tons was disposed of. Of the 1940 exports, nearly half (144,359 tons) was sent to Chile, the United Kingdom came next with 33,152 tons, 27,880 tons went to U.S.A. and 25,635 tons to Siberia, a new destination. In 1936 the export to the U.K. was 127,604 tons.

JAMAICAN SUGAR FACTORIES.—A recently published table of data relating to the 27 factories now operating in Jamaica[1] gave the maximum capacity in long tons of sugar of the largest factories to be as follows: Frome, 40,550; Monymusk, 24,150; Bernard Lodge, 18,700; Gray's Inn, 15,000; Jamaica Sugar Estates, 14,000; Caymanas, 12,000; and United Estates, 7,500. Other factories have capacities from 7,100 tons downwards, the total for the island being 215,550. Other data given are: size of mills, grinding rate t.c.h., tons cane per ton sugar, and nett grinding days.

[1] *The J.A.S.T. Quarterly*, September, 1940.

Sugar-House Practice.

Unit Liquid Heaters. A. L. Webre. *Proc. 13th Conf. Assoc. Sugar Tech. Cuba*, pp. 21-33.

Each unit consists of a standard length of C.I. flanged pipe, 12 ft. long, to each end of which is bolted a standard C.I. tee, the side branches of the tees being 180° from each other in a vertical plane. To each end of this assembly is bolted a tube sheet made of copper or other suitable metal drilled to receive 1½ in. tubes making up the heating surface. Each of the tube sheets is fastened to the flanges of the tees by means of countersunk bolts straddling the regular flange bolts so that the two tees, the 12 ft. length of pipe, the tube sheets and the tubes are assembled as one unit, and can be independently tested, if desired.

Each of these units constitutes one pass of the heater, which consists of as many passes as may be desired, usually in even number combinations. The ends of adjacent units are connected either by return bends or pairs of elbows, and the liquid inlet at the bottom, as well as the liquid outlet at the top, are made of offset reducers, bringing the dimension down to a pipe size corresponding approximately to the sum of the internal areas of the tubes in one unit. One of the tees in the top unit provides the steam inlet, and one at the bottom is used as the condensed steam outlet. Venting is done at this point also, where all the non-condensible gases are driven.

At this tee is provided a water gauge-glass to show whether or not the condensate is being properly removed. The support of the vertical bank of elements making up the heater is accomplished simply by the use of four angle irons of adequate size bolted to the flanges of the pipes between the tees. The bottom of each pair of these angles is tied together by means of a small base plate with clips rivetted on, which not only prevents the angles from spreading but also provides adequate bearing surface to support the weight. No cross bracing is necessary as the rigidly bolted C.I. pipe and fittings make ample provision for this.

Such an arrangement for the construction of heaters is a wide departure from the conventional design. Advantages that it has been proved to possess are that the separate tube sheets are made of material not subject to breakage; that the difficulty and annoyance of holding and staybolting the covers to the heads of old heaters is eliminated; and that steel shells and steel baffles all liable to corrosion and wear-and-tear are not used. Moreover, such heaters can be used as heat exchangers for warming the cold raw juice by means of hot condensate from the evaporators. As much as 50 to 60°F. can be gained in the initial temperature of the juice by this simple and economical method.

Regarding the matter of cleaning, the washout pipe should be so arranged that one heater can be cleaned while the others are in operation. One can employ, for example, two small headers, one above the heaters and one below, and at each heater in each header is a 3-way cock. A tank is provided for the cleaning caustic soda liquor, and a pump for circulating this cleaning solution through the heater under treatment. Then it must be mentioned that it has been found practicable to clean heaters simply by circulating through them unlimed raw juice, the acidity of which removes the scale in very practical manner.

Purity Rises occurring in Evaporation. J. Marchés.[1] *Archief Suikerind. Nederl.-Indië*, 1940, **1**, pp. 225-230.

Purity rises occurring during the evaporation of thin to thick juice are quite frequent, leading one to enquire if this phenomenon is real or apparent, and to what cause or causes it may be ascribed. Here are some figures from Java mutual control returns showing the extent of such rises for the three types of factories concerned :—

	Defecation.	Sulphitation	Carbonatation.
1935	1·0	1·0	0·4
1936	0·7	1·0	0·2
1937	0·7	0·8	0·4
1938	0·8	0·9	0·5

As possible causes of such rises one can consider : (1) a real rise, due to the elimination of non-sugars during the evaporation; (2) an apparent rise due to the transformation of optically-active substances; and (3) an apparent rise, due to errors in the analytical methods used. These causes are discussed *seriatim* below :

(1) Non-sugar elimination can take place in the gaseous state with the elimination of CO_2 to form part of the incondensible gases and to some extent to pass into the condensed water. Pavlas[2] carried out laboratory investigations in this direction in which he boiled beet juices and examined the distillates. By determining the CO_2 and NH_3 in these, he calculated the loss in the density of the treated juices, due to the decomposition which had occurred, finding it to amount to a maximum of 0·02° Bg., which would explain a rise in purity of only about 0·1.

Non-sugar elimination can of course take place by the elimination of incrustation-forming constituents, in which connexion it was found that 20,000 q. of Brix, about 1,000 kg. of scale, were obtained. It follows from these figures that the purity of the thin-juice thus evaporated should only have risen from 87·00 to 87·04.

[1] Sugar Experiment Station for the Java Sugar Industry, Pasoeroean.
[2] *Zeitsch. Zuckerind. Czechoslov.*, 1936, **60**, pp. 129-136; *I.S.J.*, 1936, p. 391.

(2) Transformation of the dextrose and levulose present in cane juice undergoing evaporation can occur as the result of the Lobry de Bruyn and Alberta van Ekenstein reaction. According to THIEME,[1] using some figures of VAN DER LINDEN, the rotation of the reducing sugars may increase or decrease during evaporation, some of the figures presented (giving °V.) being as follows :—

	Raw Juice.	Thin Juice	Thick Juice.
Defecation	—25·6	—25·7	—27·2
Sulphitation :			
cold	—26·1	—14·2	—16·5
hot, at 60°C.	—26·8	—21·4	—19·0
hot, at 80°C.	—26·5	—19·7	—18·9
Carbonatation :			
single	—16·7	— 2·2	—12·4
	—27·8	— 5·8	— 6·1
double	—27·2	—15·6	—13·5
	—33·4	— 8·1	— 8·3
De Haan	—25·9	— 9·4	—10·1

(3) Errors in analytical methods are last considered. Figures for Czechoslovakian beet sugar factories[2] show purity rises from 0·70 to 0·86 during evaporation, which rises cannot, of course, be the result of transformations of the reducing sugars, these being absent. Examination, however, shows that they are the result of the analytical methods used, according to which the thick juice is diluted for the analysis and the thin juice is not, while errors occur due to contraction taking place on dilution occur. In Java, however, such errors cannot arise, as the two analyses are made under comparable conditions.

On the other hand, alterations in the polarization can occur as the result of the use of neutral and of basic lead acetate for clarification, but these must be very slight. Having considered the above possible causes for the occurrence of rises of purity during evaporation, and their possible extent, the author concludes that the exact cause remains unknown. It can be accounted for only partly by a removal of the non-sugars, and perhaps to a greater extent by the transformation of the reducing sugars, but not entirely by both causes.

Automatic pH Control. J. L. CLAYTON. *Technical Communication No. 3, Bureau of Sugar Experiment Station, Brisbane, Queensland,* 1940.

Although it has not been proved conclusively that the maintenance of a uniform *pH* during clarification provides optimum conditions for subsequent sugar recovery, due primarily to the well-known lack of uniformity in the properties of different juices, nevertheless there can be little doubt that the maintenance of a constant *pH* does yield better results than the haphazard method of working formerly generally the vogue. With *pH* values ranging at random between 6 and 8·5, as inevitably occurs in the absence of control, the work of the subsiders is doubtless considerably impaired.

For several years past there have been available instruments designed for the automatic control of *pH* at the liming station, but their high cost has restricted the number of installations in most countries. Some three years ago the first model of the Queensland *pH* Meter was developed to facilitate the manual control of *pH*, and its popularity has increased to such an extent that to-day very few factories in that country are without one.[3] Work has since proceeded on the design of an automatic controller, which has now been perfected sufficiently for general application.

It should be made clear at the start that the automatic control of the *pH* is not to be undertaken lightly. To acquire a suitable control instrument is only the first step on the way : one has to consider the supply of lime, and the arrangements for mixing it with the juice as factors in determining the effectiveness of the installation. In this paper the author studies what part the characteristics of the liming process play in the operation of the various systems of *pH* control. Although quite a number of control systems are available, only two main types have so far been used in Queensland.

These are designated as (1) "constant-speed floating control" and (2) "on-off" control. In the former method lime flows continuously into the juice, and whenever the *pH* of the juice exceeds the limits of an arbitrarily fixed range on either side of the desired *pH* (the dead range), the lime flow is altered at constant rate in such a direction as to oppose the *pH* variation which actuated the controller. In the second system, there is no dead range and the lime supply is switched "on" and "off" according as the *pH* is below or above the desired *pH* value referred to as the control point. It is assumed that the lime supply is uniform in quality.

Time lag is always the most important single factor in automatic control. It may be reduced to a minimum by ensuring that the lime distribution system is situated close to the liming point and by promoting good mixing between the streams of juice and lime so that a uniform sample may be promptly passed to the controller electrodes. There is really little to choose between the two systems on the score of performance, and an accuracy of about ± 0·15 *pH* units may be obtained.

Two on-off control installations have so far been made in Queensland. The first is a modification of the Pepeekeo liming system as described by FRESHMAN,[4] in which the electrodes are situated on the side of the tank and juice runs from the tank by gravity feed through the electrode chamber and returns to the stream entering the mixing tank, the time lag from tank to electrodes being extremely

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[1] *Archief*, 1931, Meded. No. 19, p. 728.
[2] *Zeitsch. Zuckerind. Czechoslov.*, 1938, No. 40.
[3] *I.S.J.*, 1941, p. 21.
[4] *I.S.J.*, 1940, p. 258.

small. The second differs, in that the lime flows in a constant stream, and by means of a moving channel the whole supply is diverted either to the juice or back to the lime supply tank, the lime being added to the juice in a "SumaMix" constant liming apparatus with the electrodes mounted over the tank and dipping into the main body of the juice.

Manufacture of High-Test Inverted Molasses, using Activated Yeast. FERNANDO GUERRERO. *Proceedings of the 13th Conference of the Association of Sugar Technologists of Cuba*, pp. 311-317.

In Cuba the manufacture of so-called high-test inverted molasses (for use in distilleries) has attained a rather considerable dimension, 92 million gallons having been produced in 39 mills during the past crop. Most of this was made with the use of sulphuric acid for effecting the inversion,[1] which is here described as a primitive procedure, having a destructive effect on pans, pumps and tanks. But, in place of acid, the use of the invertase present in yeast has been advocated,[2] and in this article the application of this process is described, using a special preparation here termed "the new activated yeast."

When, a few years ago, the author began to try out this inversion method, he used ordinary bakers' yeast, the inverting power of which is admittedly low; later he used a specially selected yeast, and obtained better results; but now, with the new activated yeast, an inversion power about 8·5 times that of ordinary yeast is obtained.

This inversion power is measured by the "inverton," which is the amount of enzyme required to produce 5 mgrms. of invert sugar in a 5 per cent. sucrose solution per minute at a temperature of 55°C.; and applying this unit to the different types of yeast the values obtained are: ordinary bakers', 37·8; specially selected, 170; and new activated, 320 invertons. It is, therefore, clear that much progress has been made in making a highly active form of invertase preparation.

For the manufacture of 1000 galls. of the high-test molasses with sulphuric acid as hydrolyst, the cost of the acid is $1·10, but the cost of the necessary yeast invertase preparation is rather less, namely about $0·85, and there is no plant deterioration to take into consideration. This deterioration in the case of acid has been estimated to be as high as $1·00 per 1000 galls. of high-test molasses manufactured.

Some graphs are shown in the original paper showing times of inversion from 8 to 18 hours on syrups of different Brix and *pH* and at different temperatures and using different amounts of yeast preparation. In general, it appears from these figures that the conditions necessary for the yeast invertase hydrolysis are: density, 52 to 60° Brix; temperature, 50 to 60°C.; *pH*, 6·0 to 7·0; time, about 8 hours; amount of preparation, about 5 lbs. per 1000 galls. of the sugar liquor; and time to effect a 70 per cent. inversion, about 8 to 10 hours.

Possibilities of Integral Imbibition. J. G. SALINAS. *Proc. 13th Conf. Assoc. Sugar Tech. Cuba*, pp. 133-163.—In this article the theme is lengthily discussed that the loss of sugar resulting from the bacteriological contamination of the dilute juices as the result of their circularizing in compound imbibition is such as to nullify entirely the assumed advantages of this system as compared with simple or integral imbibition. Therefore, provided always that evaporator capacity and fuel supply allow of the application to each grinding of a sufficient amount of water to produce an adequate admixture with the original, re-utilizing dilute juice should be abandoned. Greater attention should be given to the hygiene of the mill, which should be washed down with water and disinfectant media every 8 hours. This would go some way at any rate towards ensuring the ideal of the asepsis of the mill juices, and the result would be that the fall in their purity at present to be observed would be considerably reduced with favourable repercussions on the efficiency of clarification. Numerous diagrams illustrate different possible systems of imbibition, simple and compound.

Decomposition of Sugars in Boiler Waters. F. KULHANEK. *Listy Cukrovar.*, **58**, pp. 157-162; through *Chem. Abs.*, 1940, **34**, 7644-7645.—For 0·5, 1·0, 2·0 and 4·0 hours 0·01 *M* solutions of sucrose were heated in an autoclave at 150 to 170° C. and 6 to 8·6 atm. pressure in the presence of 0·0008, 0·0016, 0·003, 0·006, 0·008, 0·009, 0·011, 0·14, 0·16, 0·20 and 0·24 *M* NaOH, Na_2CO_3 and $Na_3PO_4.12H_2O$. Under these conditions, decomposition was so complete that the solutions failed even to reduce Fehling's solution or even to react with α-naphthol. Decomposition products resulting were acidic in character, consuming from 0·3 to 0·5 of their weight in equivalent units of titratable sodium hydroxide.

Practical Rule for Electric Wiring of Motors. A. R. RUIZ. *Proc. 13th Conf. Assoc. Sugar Tech. Cuba*, pp. 93-97.—To find the area of the cross section in the electric wiring of motors, and especially to ascertain the voltage drop and the power factor, recourse is generally had to rather complicated formulae; but by means of the following simple expression sufficiently accurate results for most practical purposes can be obtained: Gauge in circular mils × 3·25 × H.P. × ft., a table then giving the corresponding sizes of wires (B. & S.) A mil is defined as a wire which is one-thousandth of an inch in diameter, its cross-sectional area being 1 circular mil.

[1] *I.S.J.*, 1940, p. 115.

[2] *I.S.J.*, 1940, p. 258.

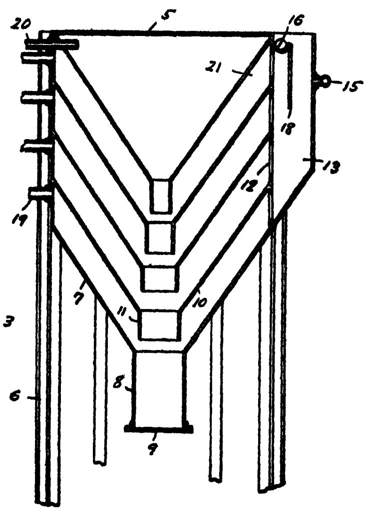
Review of Recent Patents.

Copies of specifications of patents with their drawings can be obtained on application to the following—*United Kingdom*: Patent Office, Sales Branch, 25, Southampton Buildings, Chancery Lane, London, W.C.2 (price 1s each). Abstracts of United Kingdom patents marked in our Review with a star (*) are reproduced with the permission of the Controller of H.M. Stationery Office, London, from the Group Abridgements issued by this Department. Sometimes only the drawings are so reproduced. *United States*: Commissioner of Patents, Washington, D.C. (price 10 cents each). *France*: L'Imprimerie Nationale, 87, rue Vieille, du Temple, Paris. *Germany*: Patentamt, Berlin, Germany.

UNITED STATES.

Juice Clarifier. ASHTON K. SMITH, of Franklin, La 2,205,934. June 25th, 1940.

The primary object of the invention is to provide a clarifier which eliminates the use of any moving parts. Referring to the drawing, 5 designates a tank, square in cross section, closed on all sides including the top, having inwardly inclined bottom walls 7 converging towards the centre of the tank with a central portion at the base to form a sediment trap 8. Arranged in the tank are a plurality of vertically spaced baffles 10, in the form of funnels, formed at their bases with spouts 11 of successively decreasing diameter.



One of the side walls has spaced openings 12 communicating with the interior of the tank above each of the respective baffles 10, said openings also providing communication with a chamber 13, which is open at its top, and provided with a feed-pipe 15. This chamber 13 constitutes a scum compartment, and is provided with a trough 16 having a drain 17 with a depending baffle 18. At the side of the tank are drain pipes 19 between each of the baffles 10 with a similar drain pipe 20 above the uppermost baffle.

In operating the clarifier, hot juice is admitted through feed-pipe 15, the baffle 18 maintaining the scum and other light floating matter in the compartment 13, the liquid level of the juice being maintained so as to allow the floating matter to overflow into trough 16. From the compartment 13 the juice flows through openings 12 into the main tank, the heavy material settling upon the surfaces of the baffles 10 to later fall through the spouts 11 into the sediment trap 8. Finally, clear juice is drawn off through all or any of the drain-pipes 19 and 20 to be collected in the evaporator supply tank.

Manufacture of Cane Sugar (Three-Massecuite Process). GEO. E. STEVENS (assignor to THE WESTERN STATES MACHINE CO., of New York). 2,217,604. October 8th, 1940.

Boiling processes at present used in the manufacture of cane sugar call for improvement. Avoidable re-introduction of non-sugars takes place, and there is too much intermixture of relatively pure and relatively impure materials, so that the directness of the route from incoming raw material to low purity end-material is impaired and over-all process efficiency is reduced. Double purging may decrease the re-circularizing of non-sugars, but this means additional equipment and additional work.

In one embodiment of the present invention to overcome these defects, raw cane sugar is manufactured from meladura (evaporator syrup) by a 3-massecuite process involving the direct production of marketable raw sugar having good keeping and refining qualities from each of the three massecuites, the maintenance of third massecuite at a fixed low purity, and the maintenance of first massecuite at an abnormally high purity; the third, or crystallizer, sugar produced by this process may be blended with first and second sugars and shipped to market, or it may be mingled with meladura and used as seed for first or second massecuite boilings or for both.

In another embodiment, cane sugar of extra high quality having a purity of 99·0 to 99·5 is produced directly from the first and second massecuites, and this may either be marketed as plantation raw sugar of better than usual quality or melted and passed through a conventional refining process for the production of refined sugar, without intermediate affination treatment. In this embodiment also, the first massecuite is kept at an unusually high purity; the second massecuite is maintained in proper relation to third massecuite purity by fractionation and distribution of centrifugal run-offs. Reference is made to U.S. Patents 2,086,951[1] and 2,145,633[2] as suitable apparatus to be used in these operations.

Claim 5: A 3-massecuite process for producing raw cane sugar and final molasses from meladura which comprises boiling first massecuite of at least meladura purity from incoming meladura, on seed

[1] *I.S.J.*, 1938, p. 41. [2] *I.S.J.*, 1939, p. 441.

sugar of at least 97° purity, and centrifuging the massecuite to produce first sugar of at least 96 polarization and first molasses of about 20 or more points lower purity than the first massecuite, boiling second massecuite from first molasses on seed sugar of at least 97° purity, and centrifuging the same to produce second sugar of at least 96 polarization and second molasses of about 20 or more points lower purity than the second massecuite, boiling third massecuite, on seed provided by a portion of said second massecuite, from said second molasses and a run-off fraction from third massecuite purgings of about third massecuite purity, cooling and further crystallizing the boiled third massecuite, re-heating the same just before centrifuging, purging the re-heated massecuite to extract at least 90 per cent. of the mother-liquor from the third sugar and then washing the sugar to a purity of at least 97°, sharply separating the streams of mother-liquor and wash syrup expelled from the sugar so as to obtain final molasses of usual low purity and the aforesaid run-off fraction, respectively, and using said third sugar on the aforesaid seed sugar.

Claim 10 : A 3-massecuite process for producing high purity cane sugar and final molasses from the meladura which comprises boiling first massecuite, on seed sugar of high purity, from incoming meladura and a "high first" run-off fraction, purging mother-liquor from the massecuite, washing the first sugar in centrifugals and continually fractionating centrifugal run-offs to produce first sugar of a least 99° purity, a "low first" run-off fraction consisting essentially of mother-liquor and said "high first" run-off fraction consisting substantially entirely of wash syrup, boiling second massecuite, on seed sugar of high purity, from said "low first" fraction and a "high second" run-off fraction, purging mother-liquor from the second massecuite, washing the second sugar in centrifugals and continually fractionating centrifugal run-offs to produce second sugar of about 99° purity, a "low second" run-off fraction consisting substantially entirely of mother-liquor and said "high second" fraction consisting essentially of wash syrup, boiling third massecuite, on seed provided by a portion of said second massecuite, from said "low second" fraction and a "high third" run-off fraction, cooling and further crystallizing the boiled third massecuite, re-heating the same just before centrifuging, purging the re-heated third massecuite to extract at least 90 per cent. of the mother-liquor from the third sugar, washing the sugar to a purity of at least 97° and continually fractionating cent ifugal run-offs, to produce high purity third suger, said "high third" run-off fraction consisting essentially of wash syrup, and final molasses consisting substantially entirely of mother-liquor, and using said third sugar as the aforesaid seed sugar.

Refining Sugar [A Process eliminating Affination]. EUGENE ROBERTS and GEO. E. STEVENS (assignors to THE WESTERN STATES MACHINE Co. of New York). 2,217,598. October 8th, 1940.

This invention utilizes the discovery that the preliminary purification of grain sugar (e.g., raw sugar) contaminated with surface impurities can be carried out to advantage by mingling of the sugar with a massecuite produced in the normal operation of the plant. The process, therefore, aims at eliminating the affination step in refining as ordinarily performed.

In its operation, regulated streams of massecuite from one of the vacuum pans and of raw sugar from bins are introduced into a conveyor, where they are mixed to some extent, and from which they pass into a distributor as a thick viscid mass. This drops into a mingler tank where it is thoroughly stirred while dry heat is introduced from the revolving coils (apparatus described by E. ROBERTS, serial No. 83,634 being used).[1] It is then discharged into the centrifugal machines below.

During this treatment adherent surface impurities carried by the raw sugar grain are softened and moistened, the vigorous mingling operation causing these to be loosened from the crystals, all without dissolving any substantial amount of the crystal. The operation of the mixing and conditioning apparatus is substantially the same as claimed by GEO. E. STEVENS in U.S. Patent No. 2,175,998.[2] The washed sugar recovered from the centrifugals attains a purity of 98·5 at least. By the practice of this process, highly economical operations result in the case of a refinery producing part of its white sugar output from cane juice and the remainder from imported raw sugar, the same mingling and centrifugal equipment being used for the purging of the massecuites and for the affining treatment of the raw sugar in the manner described.

Claim 1 : The process of refining sugar which comprises combining massecuite with granular sugar having adherent surface impurities, heating the combined materials so as to impart a fluidity suitable for efficient separation of solids from liquid, and thereafter separating grain sugar from the liquid content of the combined materials. Claim 4 : In the production of white cane sugar, the steps which comprise boiling massecuite from process materials and concentrated cane juice, mingling such massecuite with raw cane sugar, stirring and heating the combined materials to increase their temperature and fluidity and to loosen adherent impurities from the raw sugar, and thereafter separating liquid and solid constituents of the resulting magma in centrifugal machines.

[1] See also U.S. Patent, 2 055,778 ; *I.S.J.*, 1937, pp. 199-200.
[2] *I.S.J.*, 1940, p. 154.

Stock Exchange Quotations of Sugar Company Shares.

LONDON.

Company.	Quotation April 21st 1941	Quotation March 20th 1941	1941 Prices Highest.	1941 Prices Lowest
Anglo-Ceylon & General Estates Co. (Ord. Stock)	24/0 — 25/6	$1\frac{3}{16}$ — $1\frac{5}{16}$	25/3	24/6
Antigua Sugar Factory Ltd. (£1 Shares)	$\frac{3}{8}$ — $\frac{5}{8}$	$\frac{3}{8}$ — $\frac{5}{8}$	8/9	8/9
Booker Bros., McConnell & Co. Ltd. (£1 Shares)	$2\frac{3}{8}$ — $2\frac{5}{8}$	$2\frac{5}{16}$ — $2\frac{9}{16}$	52/6	47/6
Caroni Ltd. (2/0 Ord. Shares)	1/0 — 1/6	1/0— 1/6	$1/2\frac{1}{4}$	1/0
(6% Cum. Pref. £1 Shares)	21/9 — 22/9	$1\frac{1}{16}$ — $1\frac{3}{16}$	22/6	20/3
Gledhow-Chaka's Kraal Sugar Co. Ltd. (£1 Shares)	$1\frac{3}{16}$ — $1\frac{5}{16}$	$1\frac{3}{16}$ — $1\frac{5}{16}$	24/6	22/0
Hulett, Sir J. L. & Sons Ltd. (£1 Shares)	24/6 — 25/9	25/0 — 26/0	26/0	$22/1\frac{1}{2}$
Incomati Estates Ltd. (£1 Shares)	$\frac{3}{16}$ — $\frac{5}{16}$	$\frac{3}{16}$ — $\frac{5}{16}$	—	—
Leach's Argentine Estates Ltd. (10/0 units of Stock)	6/0 — 6/6	6/0 — 6/6	6/6	6/3
Reynolds Bros. Ltd. (£1 Shares)	34/6 — 36/6	34/0 — 36/0	38/0	$32/7\frac{1}{2}$
St. Kitts (London) Sugar Factory Ltd. (£1 Shares)	$1\frac{5}{8}$ — $1\frac{7}{8}$	$1\frac{5}{8}$ — $1\frac{7}{8}$	—	—
Ste. Madeleine Sugar Co. Ltd. (Ordinary Stock)	13/6 — 14/6	$\frac{11}{16}$ — $\frac{3}{4}$	14/3	11/9
Sena Sugar Estates Ltd. (10/0 Shares)	$\frac{1}{4}$ — $\frac{5}{16}$	$\frac{1}{4}$ — $\frac{5}{16}$	$6/1\frac{1}{2}$	5/0
Tate & Lyle Ltd. (£1 Shares)	48/3 — 49/3	49/3 — 50/3	50/9	46/0
Trinidad Sugar Estates Ltd. (Ord 5/0 units of Stock)	5/0 — 6/0	5/0 — 6/0	5/6	5/0
United Molasses Co. Ltd. (6/8d. units of Stock)	22/3 — 22/9	22/9 — 23/3	$25/1\frac{1}{2}$	21/9

NEW YORK (Common Shares).†

Name of Stock.	Par Value	Closing Price April 10th, 1941.	1941. Highest for the Year.	1941. Lowest for the Year
American Crystal Sugar Co.	No par	$11\frac{1}{2}$	$14\frac{1}{2}$	$9\frac{1}{2}$
American Sugar Refining Co.	$100	$15\frac{1}{2}$	19	13
Central Aguirre Associates	No par	$18\frac{7}{8}$	$22\frac{3}{4}$	$18\frac{1}{4}$
Cuban American Sugar Co.	$10	4	$5\frac{1}{4}$	$3\frac{1}{2}$
Great Western Sugar Co.	No par	$22\frac{3}{4}$	$26\frac{3}{8}$	$19\frac{7}{8}$
South Puerto Rico Sugar Co.	No par	$17\frac{1}{4}$	21	$16\frac{1}{2}$

† Quotations are in American dollars and fractions thereof

United States, All Ports.

(Willett & Gray)

	1941 Long Tons.	1940 Long Tons.	1939 Long Tons.
Total Receipts, January 1st to March 1st	690,718	589,754	579,359
Meltings by Refiners ,, ,,	660,617	581,284	555,881
Importers' Stock, March 1st	56,925	68,929	27,199
Refiners' Stock ,, ,,	239,871	376,110	196,261
Total Stock ,, ,,	296,796	445,039	223,460
	1940	1939	1938
Total Consumption for twelve months	5,712,587	5,648,513	5,604,051

Cuba.

(Willett & Gray)

	1941 Spanish Tons.	1940 Spanish Tons	1939 Spanish Tons
Carry-over from previous crops	1,184,393	588,293	729,172
Loss Sugar for Conversion to Molasses	43,524	— —	— —
	1,140,869	588,293	729,172
Production to March 1st	900,000	1,050,000	1,300,000
	2,040,869	1,638,293	2,029,172
Exports since January 1st	375,675	379,977	370,208
Stock (entire Island) March 1st	1,665,194	1,258,316	1,658,964

***Centrals grinding*, 152, *against* 157 *in* 1940, *and* 155 *in* 1939.**

The Market in New York.

As subsequent events proved, the domestic market was at its peak when our last report was written and during the period under review the tendency was towards slightly lower levels. The refined demand had already been checked by the much higher prices asked, and when some profit-taking developed in the Futures section, refiners withdrew from the market after having purchased a further 15,000 tons on the 25th March at the parity of 2·55 cents c. & f. New York. Further business since then was on a moderate scale down to 2·45 cents c. & f. and parity, total sales reported being in the neighbourhood of 60,000 tons against about 220,000 tons in the previous month. The Philippine Islands have renounced 73,000 short tons of their U.S. quota which would have been subject to the full duty of 1·87½ cents and the United States Secretary of Agriculture has re-allocated this quantity amongst other producers. The market went slightly easier on this news, but became firmer a few days later when it was announced that the U.S. beet acreage would remain unchanged, as there had previously been rumours that an increase in sowings probably as high as 20 per cent. was contemplated.

Refiners advanced their quotations on March 25th a further 15 cents to 5·10 cents, since when prices have remain unchanged.

It will not be possible to give any report on the domestic Futures market, as the daily figures for this section are no longer cabled to this side.

The No. 4 Futures contract has been quiet and without much feature, the daily fluctuations being somewhat irregular in nature but with a gradual tendency towards lower levels owing to the absence of any general support, quotations being 13 to 7½ points lower compared with a month ago. A moderate amount of May liquidation has been experienced but this was very largely absorbed by trade covering whilst 254 tenders on April 17th were quickly taken up. Hopes that the British Government might be purchasers of Cuban sugar have not yet materialized, but Cuban producers are finding a moderate outlet for their sugars by re-melting centrifugals and converting them into high testing molasses for which there is a fair demand in the United States at a price comparing favourably with the current quotations in the Futures contract. As molasses are not included in the United States quota, it will be seen that an additional outlet is created by this procedure.

C. Czarnikow, Ltd.

21, Mincing Lane,
London, E.C.3.
25th April, 1941.

Research.—"The price of progress is research, which alone assures the security of dividends."—Arthur D. Little.

U.K. Beet Prices for 1940.—The Ministry of Food has just lately agreed to allow U.K. beet growers an increased price for the roots grown in the 1940 season. The increase represents an increment of 2s. 6d. per ton over the provisional price allowed in the summer of 1940. The prices per ton of beet of 15·5 sugar content will accordingly range from 56s. 3d. to 58s. 3d. according to the factory concerned. For the 1941 crop the agreed prices are higher, ranging from 61s. 6d. to 63s. 6d., plus a bonus of 1s. 3d. per ton for roots delivered in September or after December 31st.

Organic *vs.* Inorganic Fertilizers.[1]—"It is an incontestible fact that crops equal in quality to those produced by organic fertilizers can be produced by inorganic fertilizers . . . . Experiments have been carried out on the Continent in which no difference in the quality of crops produced by organic and inorganic fertilizers could be found. Broadbalk field at Rothamsted has grown wheat for 98 years. Taking the plot which has received farmyard manure every year, and the one which has received inorganic fertilizers, there is no appreciable difference in the baking quality or the vitamin content of the wheat grown. Nor is there any difference in the susceptibility of the plots to disease, and although there is a difference in the weed flora there is no sign that the wheat on the artificially fertilized plots cannot stand up to the weeds as well as that on the organically fertilized plot."

Alcohol Production in U.S.—For the fiscal year ended June 30th, 1940, the production of ethyl alcohol in the U.S. amounted to 243,727,766 proof gall., a record high figure. It was 42,693,908 proof gall. above the figure for 1939. It was made in 37 plants, and the materials used were: molasses 68·6, ethyl sulphate 25·1, grain 5·7, and other materials 0·6 per cent.

Dorr Processes and Equipment.[2]—Some of the daily tonnages of major products processed by Dorr machines and equipment for grading, thickening, clarifying and filtering are as follows: cane sugar (entire world), 12,000 tons; beet (U.S.A. only), 2,000 tons; concrete and sand, 225,000 tons; phosphate rock, 15,800 tons; and cement, 32,000 barrels.

Continuity of Research.[3]—"Research such as is carried out in the Department of Chemical Technology is not a mass of disconnected experiments that can be broken off at any time arbitrarily chosen, and renewed successfully by other men, or in another place. Research at the present day, if it is fundamental in its nature and of industrial importance, must be planned for a long time in advance, and it is best carried out by a team accustomed to work together under a captain they trust. The time for changing the captain—if we are considering the problem in relation to the value of the research—is not to be determined by the progress of time, but by the progress of the research. Time is uniform in its flow, research is not. A particular month in a particular year may coincide with the culmination of a great attack after months of careful preparation; that is not the time to change a trusted and capable leader."

[1] G. V. Jacks: *Journal of the Royal Society of Arts*, 1941, 89, No. 4582, pp. 229-244. [2] *Chem. & Ind.*, 1941, p. 139.
[3] The late Prof. Wm. A. Bone, D.Sc., Ph.D., F.R.S., formerly Professor of Chemical Technology, Imperial College of Science and Technology, London.

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Notes and Comments.

The War.

A month ago Greece was the scene of a severe struggle, in which British forces were helping the Greeks to fight a rearguard action against a German invasion. Unfortunately a large section of the Greek army which was retiring from the Albanian battlefield on the Allies' western flank was cut off by a superior German force and, running short of supplies and munitions, had to surrender. It was only a question of time, then, ere the British forces had to retire to the sea coast south of Athens. Once more an epic of Dunkirk was enacted, this time under even more difficult conditions. About three-quarters of the British forces originally sent to Greece, as well as some Greek units, got safely away to Crete and Egypt, thanks to the support of our Navy. The stand made in Greece seems to have been fully justified; apart from the Greek determination not to surrender their country without a fight, the Allies had a good opportunity of measuring themselves against the German military might and inflicting severe losses on it, which must clearly have upset the Nazi time-table. The deciding factor in the German victory was clearly their preponderance in aircraft. Again it was shown that the only answer to dive-bombers and fighters is an adequate supply of fighters of our own; and unfortunately the British R.A.F. had too many irons in the fire in the Middle East to be able to oppose the German invasion of Greece with an adequate air force.[1] The German air attack was overwhelming, and against it the ground forces of the Allies, which otherwise might have successfully resisted, at least for some time longer, the German ground invasion, had to give in and evacuate as best as they could from Greek territory. So another small country was added to the Nazi bag, but not till Greece had covered herself with imperishable glory.

Once Greece was secured, it became clear that the German aim was to push on towards Syria, the territory held by France under the League of Nations, as a stepping stone to the oil regions of Irak and Iran. Air-borne troops quickly seized various small Greek islands to use as vantage points, while the Italian Dodecanese was at their service, with all their airfields. Incidentally, it has doubtless been a matter of comment why the British left Italy in possession of those twelve islands close to the Turkish coast, including the fair-sized island of Rhodes. The answer would appear to be that British strategy did not think it advisable to disperse the limited forces available in the Middle East by seizing and garrisoning so many small islands, in view of the German technique of conveying and landing troops by air. Rather the British Command has preferred to concentrate on guarding the larger islands of Crete and Cyprus, possession of which is a necessity to the Germans if they are to use Syria to the full as a gateway to Asia and not invade Turkey at this stage.

Events seem to have proved the wisdom of this decision, for, as we write, Crete is being attacked in substantial force by German air-borne troops, aided by the ubiquitous dive-bombers; the topographical lay-out of this mountainous island is, however, no help to the invaders and the Allied forces (British and Greek) stationed there can be expected to defend the island to the last. There are few landing places and few sites for aerodromes, so the Germans have to depend on parachuted troops, for conveying which they seem to have no lack of air carriers. Here again an important factor is the ability of the Allies to put into the air sufficient forces of fighters to attack these carriers. If limited landing places hamper the enemy, they must also restrict the operations of Allied aircraft. But unlike Greece, Crete and Cyprus are both islands and British naval preponderance in those waters is a weighty factor in counteracting sea-borne attacks. And without these, the abilities of the German Command to carry all before them are considerably lessened. However, the next week or two will show better than any theoretical considerations how far their new air technique can overcome the determined resistance they are meeting.

[1] It was said by the British troops that a hundred more fighters would have turned the scale.

Vichy's Surrender.

The timely landing of British troops at Basra on the Persian Gulf appears to have forestalled an intention by the usurping ruler of Irak to hand over his country to the Germans, but his attack on the British encampments existing in that country under Treaty rights has resolved itself into a race between the British and German interests to secure the oil wells. It soon became apparent that Vichy had given the Germans permission to invade Irak via the Syrian airfields and this threw on us the necessity to attack the latter. At this stage we can only await events and see whether the French forces in Syria follow the lead of their commanding officers in obeying Vichy and hold the ropes for the German incursion or whether the Free French Forces in adjacent territory can disintegrate the French authority in Syria, and facilitate Allied intervention.

What is clear, however, is that Vichy has allowed Admiral DARLAN, a pronounced Anglophobe, to hand over to HITLER all the facilities offered by the French colonial possessions, and whatever the heart of France may feel in the matter, the Vichy Government which has abolished the Constitutional Assembly in France seems now bent on throwing in its lot with Germany, doubtless in the belief that France's ultimate fate will be the less irksome if she comes out on the side of the country which she seems to think will be the ultimate victor. So the forces of freedom have yet another enemy country to reckon with. If French Morocco and Tunisia under General WEYGAND prove as accommodating to the German demands as has Syria, the road will be opened to the Atlantic coast of Africa, and Dakar, the French colonial port, which is the nearest point to central America, can in time become a U-boat base to threaten all the Atlantic sea routes. This possibility presents the United States with a serious challenge, and may well force them to take steps which will put an end to their neutrality. All sorts of suggestions have been made in the United States as to what they can or should do. The decision rests with the President who is clearly alive to the situation ; but it is to be hoped that his well-evidenced desire to bring as many of his countrymen as possible to a realization of the dangers before he acts, may not delay matters to a stage when the task then to be accomplished will be greatly augmented.

Gains and Losses.

Not all the events of the past month have been on the debit side of the Allies however ; the German raid on Cyrenaica, after its initial surprise success, was pulled up on the borders of Egypt and there it remains with a long line of communications to maintain and a torrid season for the troops to endure. We hold on to Tobruk and from there threaten the German flank. At home German night bombers have continued to take toll of English towns and ports, and a severe attack on a night in May scarred London further and ruined many historic buildings. On the other hand, inventive genius is coming to the aid of our defenders in locating the night invaders, and an increasing toll of German bombers is being achieved, 33 being brought down on the occasion of the raid on London. Meantime, British bombing attacks on Germany are on an ascending scale, thanks to the increasing output from both British and American workshops. Also is to be noted the surprise flight to Scotland of Herr RUDOLF HESS, the Nazi next but one in succession to HITLER. The mystery of his abandonment of his German colleagues still remains to be cleared up by the Government, if they possess the facts ; but of all the explanations hazarded by those who profess to know the probabilities of the case, the most likely seems to be that he had differed from his master, so became suspect and fled to escape the attentions of the Gestapo. Whatever the explanation, it seems to indicate a rift within the lute of the German tyranny, which may be the herald of bigger things.

Lastly comes the news of an encounter with strong German naval forces off the coast of Greenland, in which the famous 20-year old battle-cruiser *Hood* was unfortunately sunk by a lucky shot which must have penetrated to her magazines. The Germans had their latest battleship *Bismarck* in action, but it is satisfactory to know that the British Navy with the help of its Fleet Air Arm was able to hunt the enemy ship down in the wide spaces of the Atlantic and finally sink her 400 miles off Brest. So the *Hood* was speedily avenged.

Supplying the United Kingdom with Sugar.

Since the Government in London took over the control of the United Kingdom sugar supply on the outbreak of war, the market ceased to exist so far as this country was concerned and the usual detailed statistics as to consumption and supply were no longer available, save as speculative calculations. Obviously the Government took the line that the less information published the better for our economic struggle with the enemy. The Board of Trade ceased to publish the monthly figures of imports and consumption. Exact figures of the home beet production were also withheld, though approximate figures have been given in the House of Commons which might or might not have been exceeded in actuality. It has been left largely to American statisticians and also to the well-known German firm of F. O. Licht to make speculative estimations which have a wealth of experience behind them but probably few actual data. It is to be noted that Germany also has suspended all information as to her beet crop, for Licht is silent on that point in his more recent estimates, as also of Poland and France.

The result is that international statistics remain very incomplete and where given are calculated more from, at best, strong probabilities than from actual figures which in normal times would be freely avail-

able. This is an inevitable consequence of the war which necessitates supply of all kinds to the combatant countries being shrouded in mystery.

Some New York statisticians, in particular Dyer & Co., have attenpted to estimate the probable U.K. requirements in sugar (based on the known facts of rationing) and the sources available for supplying them. Dyer & Co. estimate the annual requrements at around 1,408,230 short tons, raw value, which includes domestic consumption, manufacturers' and caterers' rations, Service requirements, export, and supposed losses from enemy action. This compares with about 2,575,000 short tons telquel before the war. Obviously the wartime requirement can be easily supplied from the sugar grown in the United Kingdom and that produced by the Empire. The U.K. beet supply is reckoned at 500,000 long tons more or less, while the Empire supplied on the three-year average before the war about 1,228,000 long tons and has since then increased its output by perhaps 20 per cent.

For the first fifteen months of the war, the British Sugar Control's buying policy was clearly based on the principle of purchasing as much of the sugar required from sterling countries and not from dollar or florin sources. For this reason little or no Cuban sugar was absorbed. After the seizure of Holland by Germany, the Dutch East Indies were put on a sterling basis with the United Kingdom and this enabled Java sugars to be purchased at an advantageous rate. But with the Mediterranean closed through Italy's entry into the war, the long route round South Africa was the only one left available for Australian and Java sugars and with increased enemy activity in the Atlantic, it is not surprising that the Ministry of Food should drop a hint that these long-distance sugars are increasingly affected by the acute shipping problem. Speculation, in fact, exists in America whether the shipping problem will temporarily outweigh the dollar problem and force the U.K. to draw to some extent on Western Hemisphere sugars with their shorter route to this country rather than risk the long voyage from the more remote parts of the Empire. In that event it seems agreed there is a sufficient potential supply offering in the Western producing areas, not only to meet a problematical demand from this country but also to replace the 980,000 tons from the Philippines to the U.S.A. which might be cut off in the event of Japan entering the war in aid of the Axis.

The shipping problem, so far as the United Kingdom is concerned, rests entirely on the outcome of the Battle of the Atlantic which not only involves our ability to receive from America in face of the enemy attacks the much needed armaments that are being sent over in increasing volume, but also the ability to keep a sufficient number of food ships in commission out of all the demands on shipping which the war entails. Recent shipping casualties have been the heavier for considerable losses of vessels off the coast of Greece, and though this particular campaign has terminated, the lost ships have all the same to be replaced by new tonnage built in both British and American yards, or by further seizures of laid-up enemy ships.

Recent enactments in this country would suggest that the Sugar Control may be prepared to reduce the sugar requirement yet further if need be. For example, unlike last year no sugar is to be available this summer for those possessing private orchards and wishing to preserve their own fruit in the form of jams. In part the jam ration more recently instituted has interposed a difficulty and last summer extra sugar was clearly acquired by persons who did not apply it to the specified purpose ; but in the end it boils down to the presumption that there is no sufficient reserve of sugar in sight to take risks with. Again, the sugar supply to caterers to cover table allowances for sweetening hot beverages was to have been cancelled this month, but the edict has now been postponed, in the light of the immediate supply position.

The position, however, seems to be that till the seas are safer and the percentage of shipping losses is reduced, the United Kingdom will not only not increase her sugar imports but might need to reduce them further. As a consequence stocks will tend to be built up in countries of production waiting not so much for a potential market as for means of transport to the destined consumer. Yet the consumer of sugar in the United Kingdom admittedly cannot complain that his ration has been unfairly reduced in relation to other rationed foods. Most consumers would agree that the meat ration is a much smaller percentage of normal requirements for those who regularly consume it than is the sugar ration. But the latter is universal and demands proportionate consideration, whereas the percentage of a population that eats meat daily is probably not as high as might be supposed.

Sugar Politics in the United States

In preparation for the expected new sugar legislation in the States to replace the 1937 Sugar Act, some American continental sugar producers are, not unnaturally, pressing for preference for continental and insular production, at the expense of the Philippine importation. The programme of the *Sugar Journal* of New Orleans is given as a demand that Congress should institute legislation that would, from 1942 onwards, permit a 5 per cent. annual increase in the sugar quota allotted to American sugar growers, and would ensure better prices for the latter and stability to the industry. This 5 per cent. increase annually (say 180,000 tons), which should extend over a ten-year period, is to be accomplished, say its sponsors, through the replacement of Philippine sugar by American-grown sugar. In any case, the export

duty on Philippine sugar as at present arranged will increase during the next five years at the rate of 5 per cent. per annum—a circumstance which will tend to cause those imports to decline. But our contemporary's view is that the sugar resulting from a 5 per cent. increase in production granted American growers between 1942 and 1946 should be carried over and held in reserve till 1946 when the Philippines receive their independence, rather than be used in making up any deficit in the Philippine quota in the intervening years. Thereby approximately 900,000 tons of American-grown sugar would be available to replace Philippine sugar in the American market. After 1946 the American sugar industry should be no longer forced to suffer, argues this political party, because of a Philippine sugar quota.

Apart from this dead set against the Philippines, there are plenty of influential sugar interests in the States, said to be intent on reducing Cuba's share in the U.S. sugar supply quota and having Cuba excluded from any share in Philippine quota re-allocations, so Cuba also will need to exercise every care lest the advantages for her sugar in the American market are whittled away in any contemplated new legislation, to the advantage of the continental producer.

These are matters for the Americans themselves, through their accredited Government, to decide. But the war may introduce a fresh consideration, which will need to be taken into account by the U.S. Government, for taking the larger view, it is already evident that when the Nazi threat to the whole world is crushed for good, as every advocate of democracy hopes it will be, every nation victorious over, or freed from, the terror of tyranny will have to adopt a somewhat different orientation towards international trade. The latter belongs to the peaceable pursuits and when properly exploited makes the nations concerned the less disposed to warlike actions. But if the economic aftermath of the 1914-18 war is repeated after this one and insurmountable tariff walls are built around every area possessing a Government of its own, discontent will rear its head again and play into the hands of scheming politicians attracted by the chance to assume power over the many. On the other hand, the more a country or State is disposed to trade with its neighbours, the better the outlets for what counts most in life, the work of men's hands. Universal free trade may well be a Utopia that will never be achieved, for the reason that the Haves will always hold advantages over the Have Nots; but between that and autarky* there are degrees of give and take, which would engender good will amongst nations; and one of the chief problems facing the after-war generation will, or at any rate, should be to see how far mutual concessions can be made in the cause of such good will in the economic sphere.

[* "Autarky," it may be observed, is a word coined since the last war to represent "self-sufficiency" and is derived from the Greek αὐτάρκεια; "autarchy," an older use, sometimes employed in this connexion, implies "absolute power," and comes from αὐταρχία.]

Industrial Conditions in Trinidad.

A Committee some time ago appointed by the Governor of Trinidad to enquire into the whole question of factory and workshop control on that island has lately issued its report. As the committee state, Trinidad and the adjacent island of Tobago are primarily agricultural islands, sugar, cocoa, coconuts and latterly citrus fruit being the principal products. However, during the past 20 years the mining of petroleum oil and asphalt, and the manufacture of food, clothing and other goods have developed considerably until there are now 255 factories and mechanically operated workshops, exclusive of the large sugar factories, and the refineries and machine shops in the petroleum industry.

The committee found the health and sanitary conditions in the large sugar factories, on the oil-fields, and in some of the more modern industrial establishments in Port-of-Spain and San Fernando quite satisfactory; but conditions in the larger group of miscellaneous factories left a great deal to be desired, many of the properties being a menace to public health and safety and had a demoralizing effect on the workers. They recommend the repeal of existing factory laws and the enactment of a factory and workshop Ordinance based on appropriate sections of the United Kingdom Factory Act of 1937; with this would go adequate official inspection of factories under the supervision of an Industrial Adviser.

It seems clear from this that if industrial conditions on West Indian sugar estates leave something to be desired, as indicated in the recent Report of the Royal Commission, the most retrograde cases of industrial practice are to be found amongst the small factory ownerships domiciled in the place and not amongst the big concerns with directorates based on the Home country, who have mostly done what they could in a difficult set of conditions, even if they have not felt able to create reform measures greatly ahead of the industrial practice prevalent in the islands generally. Now that the Home Government seem in earnest in their intention to create new industrial and social conditions in the West Indian colonies and are devising legislative measures to carry them into effect, it may be assumed that the sugar industry, comprising as it does the main industry in most of the islands, will put itself in the van of co-operation to carry out such reforms as modern sociological opinion dictates. There is, generally speaking, a spirit of willingness, but reform is often a matter of finance, and there must necessarily be a limit to the extent to which private enterprise can be expected to shoulder a burden that seems more appropriately carried by the public purse.

The Sugar Cane in India.

Reports of the Imperial Agricultural Research Institute, 1938-39.

Though the Institute itself is situated at New Delhi, the Sugar Cane Breeding Section is, as is well known, situated at Coimbatore in the Madras Presidency, and it is the Report of the Sugar Cane Expert, T. S. VENKATRAMAN, who is in charge of this Section, that is of the greatest interest. The main lines of work were laid down some time ago and, for the most part, the Report offers a record of steady progress along those lines. Perhaps special interest attaches to the further work carried out with the sugar cane × bamboo cross, an account of which has been given in an earlier issue.[1]

As was there noted, difficulties arose in synchronizing the flowering of these two widely divergent plants. Partly this was due to the impossibility of predicting when the bamboo would flower but also to the difficulty of bringing the two plants within range of each other at the right time. It will be remembered that the early attempts to transfer sugar cane in pots to the bamboo clumps in the forest were rendered abortive by the inquisitiveness of the wild elephant. Later, failure having resulted from carrying Mahomet to the mountain, a relative success was achieved by transferring the mountain, in the form of stumps of bamboo, to Mahomet in the form of the cane plant at the Station. It is usual, when a bamboo is about to flower, for it to be cut as it would otherwise be a total loss. The stump, in such cases, sends out a profusion of shoots which develop inflorescences even though the stump has been transplanted and transported a long distance. By the transportation and planting of such stumps a ready supply of pollen is available daily over a period which may extend to three months, and in close proximity to the cane plant. It has been found desirable, however, to use pollen from the first flush as this yields the largest number of healthy pollen grains, grains of the last (third) flush being practically all infertile.

F_2 plants from the cross have been raised and these include some with the straight and erect habit of the bamboo and a fair number of heavily stooling plants, all valuable characters, while juice qualities are, in several cases, satisfactory. Fourteen contained over 16 per cent. sucrose in the juice while one surpassed 19 per cent., records being made in the month of January. When unripe, the juices were particularly dark coloured.

Especial attention is being devoted to two of these hybrids which have been crossed, on the one hand with popular Coimbatore seedlings and, on the other with the bamboo. In particular, one of these has been crossed with Co 356 which is a sugar cane × sorghum seedling. Over 5000 of the seedlings from this trigeneric cross are now in the field.

The general trend of the work of supplying canes suited for the main cane growing tracts situated in northern India is in the direciton of raising "safe canes," canes, that is, which will give satisfactory yields in spite of adverse conditions whether of season or disease. Such a cane is Co 285, now widely established in the Punjab. It is preferred, for instance, to Co 312 though this latter is capable of giving both higher yields and better juices. Until the millennium arrives when the ideal all-round cane becomes delivered by the plant breeder, this is the accepted policy.

TROPICAL CANES.

With the primary function of the Station, the breeding of canes adapted to the more important sugar cane areas of India (those lying in the subtropical plains of the north), solved to the extent that the older, standard canes have in large measure been replaced by the products of the Station, attention has latterly been directed to the problem of evolving more productive canes for the tropical regions of the south. This work has reached the stage when standards have been devised for assessing the value of any particular cross and, by use of this standard, certain crosses have been identified as worthy of repetition on a large scale. This standard is, average number of tillers, 5 to 5·5 ; average weight per clump, 10 to 12 lb. and average for Brix. 15 per cent. The parents which appear in the crosses which have attained this standard are the Co. numbers 243, 245, 247, 281, 290, 360 and 413 as male parents, 331, 421 and 441 as female parents, 419 as either male or female parent and the POJ numbers 2878, 2727 and 2725, all as female parents. The largest number of selected seedlings during the year were derived from the Co.'s 419 and 421 as female parents.

Among the characteristics apparent in the progeny of certain crosses are thickish stalks from Co 400 and POJ 2725, medium to thickish stalks from Co 419 and POJ 2878, a high average value for Brix. from POJ 2725 (17·88) followed by POJ 2878 (16·84), Co 421 (15·96) and Co 419 (16·59); all the above refer to the appearance of the variety as female parent. Good habit results from Co 285, Co 331 and POJ 2727 and bad habit from Co 244, Co 408 and Co 440, when these appear in the parentage.

GENETICS OF THE SUGAR CANE.

Investigation of certain of the more important, but unspecific Co canes suggested that they were triploids or aneuploid progenies of triploid forms. The cross *S. spontaneum* × *S. barberi* approximated to an auto-triploid while the cross *S. officinarum* × *S. spontaneum* appeared to be an allo-triploid with

[1] *I.S.J.*, 1939 p. 95.

auto-syndesis. Sterility in these canes was traced to chromosomal behaviour with environment having a greater influence in pollen, than in ovule sterility. The *S. spontaneum* clones with 76 chromosomes flowered later than those with fewer chromosome numbers.

OTHER INVESTIGATIONS.

Brief reference is made to observations on the nitrogen content of different canes and the relation of this to potential yielding capacity as well as on the results obtained by the repeated back crossing to *Sorghum halepense* and *S. Durra*. Extra illumination during the first three months caused no retardation of flowering but 250 hours from four 60 watt. bulbs during the fourth and fifth months delayed the flowering of Co 285 by 11 days.

Observations on the stomata showed that those of POJ 2725 and Co 421 were larger than those of Poovan and Vellai. In the latter the ratio of the number of stomata on the lower and upper surfaces was 2·08 and 2·15 respectively as compared with 1·29 in Co 241 and 1·98 in POJ 2725.

THE PERFORMANCE OF CO CANES.

Many of the earlier Co canes are now accepted as the standard canes for the cane growing tracts of India and even of the world. Of the more recent productions of the Station, Co 396 and Co 421 show promise as early and late canes respectively in the Punjab. Co 421, again, has an established superiority over Co 312 as a medium to late cane in the United Provinces. Co 356 (cane × sorghum hybrid) promises well as a medium-early cane in Bihar ; Co 381 as an early, and Co 421 as a late cane in Bengal; Co 432 as a salt resisting cane at Gosaba (Bengal) and, finally, Co 419 and 421 as plant and ratoon canes in Assam.

Seven canes have been raised to the status of Co numbers ; Co 457, POJ 2725 × Co 285 ; Co 458, Maur 55 × Co 285 ; Co 259, Co 440 × SW 111 ; Co 546 and Co 547, Co 349 × Co 331 ; Co 548, Co 412 × Co 508 and Co 549, POJ 2725 × *Sorghum Durra* × Co 331.

The preceding gives an account of the year's work at the Coimbatore Station. The following matters mentioned in other sections of the Report are of some interest.

Though the development of factories turning out cane sugar has been rapid in recent years, the indigenous products, gur and rab, continue to form the basis of an industry of no mean importance in which there is opportunity for improvement. Among the major points studied was the question of quality, particularly colour. It was found that juices clarified with activated paddy husk carbon yielded gur of better quality with less impurities and colour in the final product. Yields of first and second sugars from rab so prepared were much higher than when the rab was obtained by the indigenous method, while the rab itself matured early. Colour develops at the final stage of gur boiling even from water-clear juices and was shown to be due to an interaction between certain non-sugars and the reducing sugars. The keeping quality of gur depends on good crystal development.

Some notes are given relative to the preparation of active carbon from paddy husk. A hundred maunds of cane was found to yield 7·05 maunds of white sugar by the new carbon clarification process against 5·7 maunds by the old method ; an increased yield which more than covered the cost of producing active carbon. A new furnace has been designed which simultaneously manufactures both active carbon and gur. Many other aspects having a bearing on the economic problems involved are briefly discussed.

SUGAR CANE DISEASES.

The earlier programme of investigations has been rounded off and a new one laid down. This is mainly concerned with the testing of varietal resistance and intensive study at selected localities. Meanwhile, a brief summary of the main conclusions is given.

Mosaic.—Comparatively little loss and no reduction in quality are the main characteristics of this disease. These are associated with the low extent of natural transmission and with the recovery which occurs. The two vectors, *Aphis maidis*, the common vector in most cane growing countries, and *Toxoptera graminum*, occur and the former has been found colonizing on sorghum and a thin indigenous cane "shakarchinya" in the Punjab, and cane adjoining the sorghum crop showed a 100 per cent. infection but only on the side bordering on the sorghum. This small amount of transmission is counteracted by the phenomenon of recovery, for infected cane sets are capable of giving disease-free stalks and it is possible to make use of healthy stalks even from heavily diseased stools to provide sets. Thus, a crop of Co 313 showing 70 to 90 per cent. infection was used to provide sets for a later crop which showed only 3 per cent.

Red rot (*Colletotrichum falcatum*) and *wilt* (*Cephalosporium sacchari*).—Resistance tests compose the chief work on these two diseases, but the season showed only a poor development with small differences between the 42 tested varieties, the spread from the point of inoculation being only 14 and 10 inches respectively as compared with 50 and 42 inches in the previous year.

Smut (*Ustilago scitaminea*).—Control sufficient to bring the disease within bounds within one or two years has been obtained by roguing.

Red Stripe (*Bacillus rubrilineans*).—A severe outbreak in the Punjab supplied an opportunity for testing varietal resistance.

AGRICULTURAL.

The Report contains also some notes, mainly concerned with the seasonal variation in sucrose content of 61 varieties of Co canes grown at Delhi. H. M. L.

The Origin of Uba Marot Cane.

Though the genetic complexity of the sugar cane is so great that breeding remains and is likely to remain for some time an empirical matter, sufficient information is gradually being accumulated about the chromosomal constitution to enable a certain reliance to be placed on a knowledge of the history of the origin of the numerous varieties now under cultivation when the choice of parents has to be made. The purely empirical stage has passed, that under which the old 'land sorts' of the major crops were isolated, and the eye of the acute observer in detecting aberrant and useful plants in the mixed crop no longer suffices. It is, therefore, desirable that the parental history of those varieties which are included in any particular parentage should be identified as far as possible. Unfortunately this is rarely known accurately. The origin of Uba itself remains a mystery though certain views have been expressed on the subject, but Kassoer, originally of unknown origin, has had its parentage identified with a considerable amount of credibility. Uba Marot is another variety of which the parentage is doubtful and an account has now appeared of the search for evidence as to the true origin of this variety. It is given by G. C. STEVENSON, Geneticist to the Sugar Research Station, Mauritius.[1]

Uba Marot was discovered by L. MAROT in 1923 on the Gros Cailloux estate, Mauritius, in a field of old ratoons of 131 P. Attention was attracted to it through its extreme vigour and, from its appearance, it was thought to be a natural hybrid or a sport from Uba. As a commercial cane, it has not lived up to its promise, mainly on account of its poor juice, and it is now found only in small plots and in mixed plantings of small holders. It is, however, capable of giving reasonable yields under poor and infertile conditions.

It was first introduced into the breeding programme of the island in 1929 and it soon became evident that it was able to transmit its growth vigour to a considerable proportion of its offspring. Particularly when crossed with POJ 2878, did it yield vigorous offspring and though the earlier selections proved too poor in juice quality, there are a number of promising canes among its later offspring on backcrossing with noble canes and members of the glagah nobilization series. The evidence now obtained suggests that Uba Marot is a natural hybrid from a noble cane by a form of *S. spontaneum* occurring in Mauritius. This evidence is naturally circumstantial and is based on anatomical and cytological features.

Saccharum spontaneum occurs in a wild state in Mauritius though the fact appears not to have been recognized before 1937; but, from its distribution, it appears that it was probably introduced more than 50 years ago with the major influx of Indian immigration in the sixties. It is a form which approximates most closely with the 64 chromosome form from Coimbatore. All the anatomical and cytological evidence supports this conclusion; the habit of the plant and the morphological features are in close agreement and chromosomal determinations of the root tip have fixed the number as 64.

The chromosomal structure of the Uba Marot cane has been determined by several investigators both in Mauritius and Java where EVANS and BREMER respectively agreed in fixing the number of chromosomes at 112 to 113. This fact, of itself, disproves the presumed origin of the cane from Uba, for Uba has 118 somatic chromosomes. Moreover, the similarity in type beween Uba Marot and certain of the Coimbatore series of varieties constituted certain proof that the variety contained a proportion of the blood of some species other than *S. officinarum*. Yet, at the time of its discovery, only three interspecific hybrid varieties were known to exist in the island, the three varieties of the early POJ series, POJ 36, POJ 161 and POJ 213. Without going into detail, the evidence of the chromosomal numbers sufficiently proves that none of these could be a parent.

It would appear, then, that the Uba Marot is a natural hybrid between this local form of *Saccharum spontaneum* and some noble cane. The fact that when a noble cane with 40 monoploid chromosomes is crossed with a variety of *S. spontaneum* with 32 such chromosomes, a duplication of the chromosomal number of the noble variety may take place suggests that the number of somatic chromosomes of the F_1 is $2 \times 40 + 32$, or 112. These facts are in accord with the further fact that Uba Marot is completely male fertile and yields large populations in crosses with noble canes and certain members of the glagah blood line. Populations of selfed seedlings are, too, remarkably uniform and similar to Uba Marot itself.

The similarities between Uba Marot and a first nobilized *S. spontaneum* (Indian) seedling are not confined to the anatomical, morphological and cytological characters; they extend to physiological characters such as resistance to gumming disease. Which is the particular noble cane from which it is sprung is not so clear but the pinkish colour of the cane suggests a variety such as 131 P, in a field of which it was first found. Crosses between certain male-sterile noble varieties with red canes, such as 131 P and M 20/16, and the local *S. spontaneum* are being made in the hopes of synthesizing Uba Marot, thus repeating a proof comparable to that of the origin of Kassoer in Java. Meanwhile Uba Marot has several promising seedlings to its credit.

H.M.L.

1 *Bull.* 17, *Sugar Research Sta., Mauritius*, 1940.

Humus *versus* Artificials.

It is a curious fact that, whilst, in many parts of the agricultural world, there is a growing insistence on, and appreciation of the value of humus, in the case of sugar cane, particularly in Hawaii, Mauritius and the West Indies, the tendency is in the reverse direction. Partly this is due to recommendations being based on short-term experiments; a specific area is chosen for a particular series of experiments which last over the series of years during which the crop is grown through a number of ratoons. That area is then discarded and a new series commenced in another area. This proceeding neglects the long-term effects; and what these may be is indicated by British Guiana where the general alkaline reaction of the soil has now changed to a general acid reaction and it has here become a common recommendation to lime these soils to counteract the acidity developed. Partly, in the case of sugar cane plantations, it is a question of cost. With the extension of the use of mechanical appliances in the cultural operations, it has been found uneconomic to keep the number of stock required to produce the needed amount of pen manure. This latter objection raises the question whether the stock are economically used; whether the proportion of animal excreta to trash or other waste is not too high and whether the conditions under which the matrix decomposes are the optimum for the production of the maximum amount of, and the richest compost. To one who has seen the process of the production of pen manure, with the stock penned on a deep layer of trash or other vegetable waste and the mass beaten down by their constant treading, the thought can only occur that the conditions are far from the optimum.

It may be of interest, therefore, to give some extracts from an article by S. D. Timson in *Vuka*, the official organ of the Matabele Farmers' Union,[1] which bear on the question of cost. He points out that it is those farmers who have not seriously tried humus for their crops and have not, therefore, experience of its effect, who are most concerned with the question of cost of production. Those that have already made compost and have experienced its effects, are no longer concerned with the question of cost and have as their main anxiety the collection of more and more waste. Labour spent in turning the heap is held to cost nothing, for labour here is not paid by the piece or hour and the work is done on wet days when there is little other work to hand.

A number of examples are then given. In one case the kraal manure was carted from the kraal to the compost floor and mixed with three to four times its bulk of old veld grass, mown and carted one mile, the mown grass being collected by hay sweeps to form cocks and these brought to the loading point by hay drags. The cost of these operations was, for all operations till the heaps were made, £8. 12s. 6d., and for five turnings of the heaps, £5. 0s. 4d., total £13. 12s. 10d. which works out, for the amount of compost produced, at 8·18d. per ton. This was adequate for a 60 acre field at 7 to 8 tons per acre and the cost of carting (average distance 650 yds.) this was £3. 17s. 0d., the equivalent of 2·31d. per ton or 15·5d. per acre.

Two other examples are given taken from the Government Witch Weed Demonstration Farm. The data refer to a compost heap estimated at 500 tons on a basis of 2 cubic yards per ton but, as a precautionary measure against over-optimism, calculated as 400 tons. Of this, one lot of 120 tons was made during the winter in pits from mown veld grass, carted to the kraal where it was left under the feet of the stock for a few weeks and then pitted with soil and lime. In this case the cost was: all operations to placing in kraal, 9·3d. per ton of compost; from kraal to completion with six turns 8·1d.; total 1s. 5½d. per ton. It is pointed out that these costs are high because the crop of grass was very thin and patchy and had to be carted, and carting is the expensive item.

A further lot, yielding 62 tons compost, was made from sunn hemp stalks from a seed crop with carting to the compost floor 100 yds. The cost here worked out to 10·8d.

Both lots were carted a distance of some one mile over hilly roads and ploughed land in small lots owing to the unsuitability of the wagons. The cost, in the first case, was 4·9d. and, in the second, 6·2d. per ton. None of the above include any allowance for depreciation of implements, mowers, rakes, etc. Particulars are, therefore, supplied of some results given by P. G. Deeds[2] in which these are included. The total cost in this case was between 10·3d. and 11·8d. of which upkeep and depreciation of implements, deliberately estimated on the high side, was 0·94 to 0·78d.

It is pointed out that the expensive item in the production costs is carting. To secure the most economical results, therefore, it is necessary to consider not only the source of supply of the waste material but the fields over which the compost is to be distributed. It may here be of interest to call to mind G. C. Dymond's definition of the economics to compost production[3] in the case of the sugar cane; trash is on one field, the dung (if any) is at the stables, the filter cake or dunder is at the sugar factory or distillery, the green material somewhere else and the water anywhere or nowhere, while the result may be required somewhere else. South Africa has an advantage in that the kraal is a temporary and movable structure.

H. M. L.

[1] *Vuka* (1941), p. 61. [2] *Rhodesian Agl. J.*, 1938, *Oct.* [3] *I.S.J.*, 1938, p. 295.

The Sugar Cane in Jamaica.

Jamaica is an island with an exceptionally wide range of agricultural products. Among these sugar with fruits, particularly bananas and citrus, takes pride of place. The banana industry is highly organized and offers some of the major agricultural problems of the island and it is hardly surprising, therefore, that the investigations concerned with the sugar cane rank of secondary importance. In fact, it is the economic problems which dominate in the case of the sugar industry. The following information is taken from the Report of the Department of Science and Agriculture for the 15 months January, 1939, to March, 1940. It must be remembered, however, that the period covered was an abnormal one. Though the rainfall was above the average, the period January to August was, with the exception of March, very dry and, in some districts, the cane was so adversely affected that it failed to respond to the heavy October rains. Further adversity consisted in a hurricane in November.

The main work was directed to the testing of varieties, more particularly the newer canes which have commenced to arrive from the Cane Breeding Station in Barbados. BH 10/12 still remains the dominant cane with POJ 2878 following and POJ 2727 fairly widely planted. Unfortunately, the area under mixed canes occupies third place in the 'area planted' list. The two most promising varieties among those which have recently been introduced into estate cultivation are MPR 28 and FC 916 and comparisons are drawn between these and the standard canes BH 10/12 and POJ 2878. The former has not realized expectations as regards tonnage but gives good juice early in the season; it is more liable to rotting than the latter and does not promise to be a good ratooner. FC 916 gives a much higher yield and ratoons well but is later than MPR 28; its wider extension where BH 10/12 is badly attacked by mosaic is suggested.

Another promising cane is B 3439 which appears to be adaptable to a variety of soils and capable of standing up to adverse conditions. It has yielded better results than BH 10/12 and may be expected to replace this cane on those areas to which it is less suited. This replacement appears to be of growing importance, for mosaic is spreading on BH 10/12 in areas hitherto almost clean.

A number of new varieties have been received from the Cane Breeding Station, Barbados, through the Trinidad Quarantine Station and are being multiplied up at the Cow Park nursery, where they are less subject to mosaic than at the Hope Station at which they will be tested for resistance later. Very few of these so far tested, however, appear to be highly resistant.

For some years past a survey of the yields of sugar cane has been carried out annually in Jamaica, and the two latest surveys, those for 1937-38 and 1938-39, have recently appeared.[1] Their utility is somewhat marred by the fact that returns cover only a fraction, some 20 per cent., of the cane farmers' crops which constitute about a quarter of the total area. Characteristic, too, of Jamaica is the wide range of conditions of both soil and altitude, under which cane is grown. The natural consequence is that regional areas can be distinguished, based mainly on soil characteristics, which show a differential varietal adaptability. One of the results following from this is an unusually large range of varieties grown. Actually seven such areas or divisions are recognized, the major characters of which have been given in an earlier issue.[2]

The relative acreage of the different varieties shows no marked change throughout the survey period. BH 10/12, as has been stated, occupies the largest acreage at some 40 per cent. of the total, with POJ 2878 second at some 20 per cent. Mixed varieties come third at nearly 19 per cent. SC 12/4 shows a progressive decline in four years from 5·4 to 1·3 per cent. and POJ 2727 a progressive rise from 5·1 to 7·5 per cent.; moreover, this variety appears to be growing in popularity, for the latest plant cane area forms 11·4 per cent. of the total. A number of other varieties occupy lower percentages and, among these, may be noted Creole at 3·4 per cent. As, however, no plant canes are recorded in the latest return, it would appear that this variety is shortly doomed to extinction. One feature of interest in this connexion is the apparent tendency to prolong the period a crop occupies the ground, for the area under old ratoons (over 4th ratoons) has steadily increased.

Pride of place as highest yielder over the whole acreage falls to EK 28 with 35·51 tons per acre; at 58·76 tons per acre, however, for plant canes, it is beaten by a short head by POJ 2714 (10 acres only) with 58·97 tons. The figures for the two major varieties BH 10/12 and POJ 2878 are respectively, for total crop 28·74 and 26·80 tons and, for plant canes, 38·80 and 36·57 tons per acre.

Total figures may be, in cases like the present, somewhat misleading when there is a considerable localization of varieties to particular areas. Thus BH 10/12 occupies some 67 per cent. of Division 4 and approximately 40 per cent. of Divisions 1 to 3; but it is completely absent from Division 7 and occupies only 7 per cent. of Division 6. POJ 2878, on the other hand, occupies only some 12 per cent. of Division 4 but 31 per cent. of Division 7 where its cultivation is extending mainly at the expense of POJ 2727.

H. M. L.

1 *Bull. 23 and 24, Dept. Sci. and Agric., Jamaica*, 1940.

2 *I.S.J.*, 1937, p. 256.

The South African Sugar Season, 1940-41.[1]

All the sugar mills on the North and South Coasts of Natal and Zululand have finished their milling programmes for the 1940-41 season. In all approximately 5,300,000 short tons of cane have been crushed from which there has been manufactured 573,000 tons of sugar, comprising the following :—

	Short Tons.
Raws for Refining and for Export ..	391,500
"Illovo" and "Edgecombe" Refined ..	50,500
Mill Whites	43,000
No. 2 Grade Sugar	88,000
Total	573,000
Long Tons ..	511,607

This total tonnage was made in approximately eight months, equal to a production of, roughly, 72,000 tons per month, which compares favourably with results for the previous season, when the total output was 596,000 tons. A drop in production of 23,000 tons is therefore recorded, the decrease being almost entirely due to the lower average sucrose in cane compared with 1939-40.

Local Market.—Of the 391,500 tons of raws manufactured for refining and for export, 146,000 tons went to the Central Refinery at Rossburgh to be processed into refined as well as tablet, icing and castor sugars for South African market needs. It is estimated that the output from the Refinery this season will finally total 140,000 tons, and it is from this quantity, as well as from the other white and refined sugars produced, as enumerated above, that South African market requirements of direct consumption white sugars are being met this year.

There has been a large increase in the quantity of white sugar produced this year which is due to the abnormal demands the industry has had to meet from the commencement of the season. Sales since May 1940 have recorded an increase of 22,000 tons in whites over last year; and in making provision for consumption during the next few months, i.e., until new sugars are available on this market, reservations have had to be made to take care of a possible continuation of excess demands. It is confidently anticipated that white sugar sales for the seasonal year will total 235,000 tons, and if this materializes the increase will work out at 24,000 tons over last year's figure.

In addition to the consumption of white sugars in this market, the demand for what is known as 2 Grade continues to expand and the provision that has been made this year for that trade has been the setting aside of 85,000 tons. Sales up to the present of 2 Grade have been 60,500 tons and sufficient stocks are on hand to meet all demands until new season's sugars are available. Sales to date record an increase of 9,000 tons over last year's figures.

Exports.—With the exception of 10,000 tons of sugar sent to Rhodesia for refining, the available balance of raws, viz., 235,000 tons, has been utilized for shipment overseas in fulfilment of the export quota. The quota for export has worked out at approximately 33 per cent. and all sugar shipped has gone to the United Kingdom for conversion into refined granulated.

Shipments during 1940-41, owing to the smaller crop and the necessity of keeping extra sugar in this market to meet the increased demand experienced, were lower than those sent overseas in the previous year. With an earlier start at the mills, shipments were made in May last; and, with the exception of October, when a comparatively small total was dealt with, deliveries were fairly evenly spread over the period May, 1940, to January, 1941. As in previous years a large proportion of the tonnage went forward by chartered steamers.

All export sales this season were made to the British Ministry of Food; the average price received works out at a little over 12s. 0d. per cwt., which figure is 1s. 5d. per cwt. higher than the price received in 1939-40.

Prospects.—As far as prospects for this coming season can be estimated, all indications point at the moment to a probable reduction of 10 per cent. in the tonnage of cane to be reaped. The whole of the coastal belt is suffering from the prolonged drought, as a consequence of which the cane growth is subnormal. These circumstances, coupled with the fact that last season saw the clearance of most of the available surplus cane, will combine in bringing about a short crop in the year which will open on the 1st May 1941.

Sugar Production in Fiji.—According to Lamborn of New York, the output of sugar in the Fiji Islands for the 12 months ending August, 1940, was 120,100 long tons, raw value, as against 131,800 tons in the previous season. Local sugar consumption amounts to some 5000 tons or 54·6 lbs. per head. The surplus production not needed in Australia is marketed in Canada and the United Kingdom; in 1939-40 Canada took some 59,000 tons and the U.K. 21,000 tons.

British Guiana 1939 Sugar Crop.—According to a report of the Director of Agriculture of British Guiana, the local sugar crop of 1939 amounted to 189,245 tons, a decrease on the record output of 195,944 tons in 1936, but with better sugar prices. Of the 67,718 acres under cane, 62,004 were reaped during the year—60,383 on the sugar estates and 1,621 from farmers' canes. The general average yield of sugar per acre was 3·05 tons. Of the cane areas 37,506 acres was under POJ 2878, 24,162 under Diamond 10 and 1,804 acres under D 625. The total of rum produced by the colony during 1939 came to 1,422,571 proof gallons.

[1] From the *South African Sugar Journal*, Vol. 25, No. 2, p. 79.

Indian Sugar Affairs.

Indian Sugar Production, 1940-41.

The First Memorandum on the production of modern factory sugar in India during the 1940-41 season (issued at Cawnpore in February) states that the production of sugar directly from cane in vacuum pan factories in India this season is estimated to be, roundly, one million tons, as against the actual production of 1,241,700 tons in 1939-40. This decrease in production has taken place only in the provinces of U.P. and Bihar ; in the remaining provinces, and particularly in Madras and Bombay, production has increased, and will, it is estimated, be anything up to 40,000 tons higher than in 1939-40.

The U.P. and Bihar had a record output of sugar in 1939-40, amounting for the two provinces to nearly one million tons of sugar. But demand was poor, particularly in the earlier months of the year, and when the 1940-41 season opened the factories had heavy stocks of unsold sugar on their hands, estimated at November 15th to be about 350,000 to 400,000 tons. With unrestricted production in 1940-41 surplus stocks would have mounted by the end of the season to unmanageable proportions. The Governments of the U.P. and Bihar, therefore, took action under the powers given to them by the Sugar Factories Control Acts to restrict the production of the factories in these two provinces by means of a system of quotas. Accordingly, crushing quotas were allotted on the basis of a total sugar output for the two provinces of 720,000 tons. It had been estimated that this reduced production would leave the industry with stocks not exceeding 400,000 tons at the beginning of the 1941-42 season. This device of restricting production by the Governmental allotment of quotas is new to India and has not yet been tried in connexion with any other industry there.

The estimated number of factories working this season is 148, as against 145 in 1939-40. Seventy-one are in U.P., 32 in Bihar, and 10 in Madras. Four new factories have commenced working this season, one each in the United Provinces, Madras, Punjab, and N.-W.F.P. Recoveries are expected to be higher in most of the areas.

Production in Burma from the three factories working there is estimated at 26,700 tons of sugar from some 265,000 tons of cane.

Conditions in U.P. and Bihar.

In the annual report of the Purtabpore Sugar Co. Ltd., of Cawnpore, India,[1] for the year ending October, 1940, the directors state that the 1939-40 crushing season was one of the most difficult in the history of the industry in the United Provinces and Bihar. The policy of the Governments of these two provinces in adopting a scale for cane rates which was linked with market quotations for sugar, for the most part never realized, so raised the Sugar Syndicate's basic rates as to make it impossible for manufacturers in the two Provinces to compete with production in other Provinces and Indian States, which were in a position to undersell them and at the same time make large profits. Thus the outside production of some 250,000 tons was marketed before all but a small fraction of the U.P. and Bihar sugars could be disposed of.

Under recent enactments a body has been constituted by the Governments of the U.P. and Bihar under the title of the Sugar Commission with a senior member of the Civil Service as its Chairman. The function of the Commission is to advise Government in all matters concerning the industry and it is hoped that the numerous imperfections in the present legislation will command their early attention. From the manufacturers' point of view, however, much remains to be done by Government before the legislation imposed upon this section of the industry will be satisfactory. The industry in the two Provinces continues to press for the redress of grievances and for treatment which will enable outside competition to be met.

The Governments of the U.P. and Bihar have introduced a system of quotas for the coming season under which factories will work considerably below their capacity. The object of this restriction is to reduce the production of sugar in an attempt to bring about equilibrium between consumption and production. A minimum rate for cane has been fixed at Rs. 0/4/3 per maund, to which must be added the provincial cess of 6 pies per maund and 6 pies per maund towards the redemption of the excise subsidy. It is feared that the price which factories will now have to pay is not sufficiently low to enable manufacturers in the two Provinces to compete with those situated in other Provinces and Indian States. The excise duty levied by the Government of India was increased from Rs. 2/0 to Rs. 3/0 per cwt. in respect of sugar manufactured on and after the 1st March, 1940.

Cana.—Uruguayans are partial to the spirituous drink called *cana*, which can be distilled from fermented molasses or sugar juice with or without the addition of some honey. At its best, it is made by the fermentation of cane juice with pure yeast, and a special technique ensuring the special bouquet and flavour of the product with a good yield. Temperature control and the supply of compressed air are said to be features of this technique. The distillate obtained has a strength of 60 to 70 G.L.; it is aged in slavonian or limousine oak casks of 400 litres. According to M. Sanarens, of the Havre Municipal Laboratory, good *cana* can be compared to a fine Armagnac.[2]

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1 One of the Begg, Sutherland group of factories.
2 P. Menendez Lees in *Bull. Agric. Sci. Intern. Inst. Agric.*, 1940, 31, No 5, p. 220T.

The Application of Rotary Pumps to Molasses.[1]

By A. SHAW, J. G. REAL and V. A. PARDO.

Conditions of service in molasses pumping have changed considerably in the last few years, due especially to the increase in viscosity which has now become apparent. Without doubt, more efficient extraction through the use of improved methods and better milling equipment has had a large hand in producing this result. In the days when molasses had low viscosities, it was the general practice to pump it with direct acting steam pumps, vertical triplex, or other types of power pumps.

Take for example one installation in Antilla, Cuba, using a large steam pump, and another at Nuevitas where a very large triplex pump was used. These two pumps were not only large, requiring a great deal of space, but were very expensive. They operated satisfactorily until the viscosity of the molasses increased to such a point that the steam pump at Antilla burst the liquid end, and the pump at Nuevitas had to be changed because it could not pump such viscous material.

In place of these pumps the engineers introduced rotary type pumps (to be described later), capable of pumping efficiently and smoothly the grade of molasses now being exported, but the most important point in the change was the lower cost of the new units. That, with motor and control, which replaced the old one at Nuevitas, cost approximately 15 per cent. of the price of the power pump, while the complete rotary installation at Antilla cost about 20 per cent. of its predecessor.

Thus it is seen that by using pumps of the rotary type to handle molasses, the user would be using one especially designed to handle this type of liquid, and not an adaptation of some other type and one having a lower cost and a lower maintenance expense than either the power or direct acting pumps.

TABLE I.

COMPARISON OF PUMPS FOR MOLASSES SERVICE.

(200 galls. per min.; 300 lbs. per sq. in. pressure; 100,000 S.S.U. viscosity).

	Size of Pump inches.	Dimensions. Length, Width and Height in feet			Shipping Weight with motor lbs.	Price with motor (approx.)
Vertical Triplex	10 × 14	16	9	13	40,000	$15,000
Horizontal steam, plunger	16 × 7 × 8	10	4	4	7,100	$1,900
Rotary	5-GR	7	2	2½	3,200	$1,500

Centrifugal pumps cannot be used due to the high viscosity and the resistance to flow in the impeller. Steam or power pumps may be used, but they require a great deal of space, and are expensive from the standpoint of initial cost and maintenance. Another of their disadvantages is that they present a very crooked path for the molasses to follow, besides the resistance of the two sets of valves. It is not really wise to use either steam pumps or power pumps of the reciprocating type for this class of service.

TABLE II.

Mill.	Type of Molasses.	Brix.*	Temperature °F.	Viscosity S.S.U.
A	Final	87·00	100	17,000
B	,,	87·38	100	51,000
C	,,	87·50	100	186,000
D	,,	88·42	100	150,000
E	,,	88·60	100	85,000
F	,,	89·34	100	50,000
G	,,	89·70	100	175,000
H	,,	90·60	100	186,000
I	,,	90·62	100	128,000
J	,,	90·85	100	303,000

* Brix referred to 20°C.

In discussing the initial cost of a rotary pump one must keep in mind that there are several factors which must be considered in order to select and apply it as economically as possible to the particular job. Three basic qualities of the liquid must be known in order to pump molasses and sugar syrups successfully.

Of these the most important is the viscosity of the molasses, or its resistance to flow, taken at the lowest pumping temperature. The second is possibly acidity which should be checked as, of course, corrosion would considerably shorten the life of an all-iron pump. For acid molasses, all-bronze pumps should be used. The third quality is the possibility of abrasiveness in the liquid, due to sugar crystals which will tend to wear out a close clearance pump. Where abrasives are present, other types of pumps must be used, such as the "Magma"; depending, of course, upon other conditions as well.

Table II compiles figures for viscosities and Brix, obtained by tests on Cuban molasses. It will be noted that while the Brix remains closely the same, the viscosity is subject to wide variation, which shows the lack of correlation between Brix and viscosity. Therefore, it is important to know the viscosity of the molasses to be pumped separately from the Brix.

Viscosity is measured in terms of the number of seconds it takes a fixed volume of the liquid to pass through a small tube of fixed dimensions. Different experimenters have used different sizes of tubes, and there are several of these in use to-day. In the U.S.A. the Saybolt Universal Viscosimeter is in use. By measuring the time it takes for the fixed volume to flow through the tube, we are really

[1] *Proc. 13th Conf. Assoc. Cane Sugar Tech., Cuba* (here abridged).

measuring the resistance flow of the liquid, liquids having a higher resistance to flow taking longer to pass through the tube.

It is obvious then, that this quality is of extreme importance in pumping molasses through any kind of a pipe line. Organic non-sugars of the molasses (especially gums) offer high internal resistance to movement, the measure of which is the viscosity.

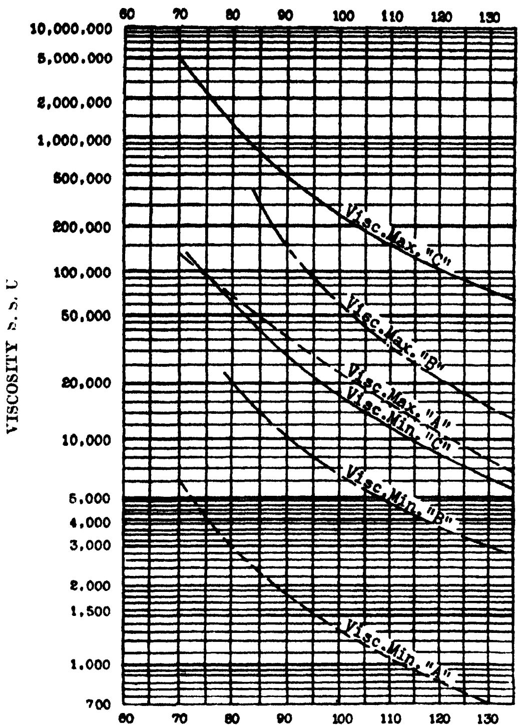

Fig. 1.

Fig. 1 shows the results of tests conducted with Cuban molasses plotted on logarithmic paper with the viscosities in S.S.U. on the ordinate and the temperature on the abscissa. All the results have been classified according to the type of molasses, and the heavy lines indicate the maximum and minimum values obtained. This illustrates very clearly the magnitude of the variation in the viscosities from different mills, and also the reason for the necessity of knowing the viscosity at the minimum temperature at which it is expected to be pumped. For instance, a normal molasses with a viscosity of 60,000 S.S.U. at 80°F. will have one of only 30,000 S.S.U. at 90°, or half as much viscosity with only 10° change in temperature. The friction loss should be added to the static head to obtain the total head against which the pump must work.

It is very important in the piping layout to figure the pipe friction in the suction line and make the piping of such a size that the pipe friction plus the static suction lift will not approach the equivalent atmospheric pressure. A pump may have excellent so-called suction qualities, but it must be remembered that the pump does not and cannot *pull* the molasses within itself. It must depend upon atmospheric pressure (14·7 lbs./sq. in.) to force the liquid into the pump. If the pipe friction plus static suction lift is more than atmospheric pressure the pump will cavitate with considerable noise and reduction in capacity.

Viscosity and its effect on the pipe line having been discussed, we will take up its importance in the selection of a rotary pump. The type in mind consists of two herring-bone gears, commonly referred to as rotors, within a close-clearance casing (Fig. 2).

When the liquid enters the pump, it must fill up the space between the teeth of the gears to be carried around and along the curvature of the casing to the discharge. Therefore, if the viscosity of the liquid is high, the pump must operate slowly in order to allow sufficient time for the molasses to enter and fill the spaces between the teeth. Otherwise, those spaces will not fill and the pump will not operate properly. Conversely, if the viscosity of the molasses is low, the pump may be operated satisfactorily at a higher speed.

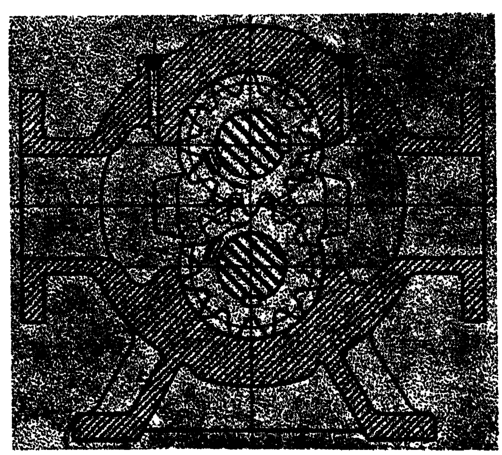

Fig. 2.

When talking about speed, it must be remembered that revs. per min. is not the true measure of the speed. The true measure is the lineal velocity of the gear teeth, measured at the pitch diameter. Taking into account the fact that the larger pump will be the pitch diameter, one arrives at the conclusion that the larger the pump, the slower it must operate in revs. per min. for the same lineal speed.

TABLE III.

AVERAGE GEAR VELOCITY IN FEET PER MINUTE.

Size of Pump Gr.	1,200	1,000	750	600	400	250
	r.p.m. corresponding to above velocities					
1½	1,900	1,582	1,189	950	633	396
2	1,530	1,275	950	765	510	318
2½	1,530	1,275	950	765	510	318
3	1,142	952	715	571	380	238
4	955	796	595	478	318	199
5	764	636	477	382	254	159
6	573	478	358	287	191	119
8	478	398	299	239	159	100
10	478	398	299	239	159	100
12	382	318	239	196	127	80
16	287	239	179	143	95·5	59·5
Viscosity	100	1,000	5,000	20,000	100,000	Over
S.S.U.	400	2,000	10,000	50,000	200,000	200,000

In Table III it is possible to appreciate the importance of the true measure of speed for various sizes of pumps. It can be seen that as the viscosity increases, the lineal speed decreases. This must be done, as has been said above, in order to allow sufficient time for the molasses to fill the spaces between the gear teeth properly. This, then, brings up the question of capacity. Since these pumps are of the positive displacement type, and capacity is proportional to speed, it follows that as the speed is decreased for the reasons mentioned above, the pump size must be increased to obtain the desired capacity.

Coming now to treat of the performance of rotary pumps, they are, as has been said, of the positive displacement type, and therefore capacity, pressure, and B.H.P., increase with the speed. Capacity is a straight line when plotted against revs. per min. increasing as the speed increases. The B.H.P. gradually increases with the speed and capacity.

Turnplate Wear and Cane Mill Losses from Re-Absorption.[1]

By JERÓNIMO DÍAZ COMPAIN, M.E.

Close inspection of the appearance of the wear of the turnplate makes it possible to trace the origin of certain errors in the operation of the grinding plant. Such findings may contribute considerably towards reducing losses from re-absorption and cost of repairs.

Observations have been made over a period of seven years after grinding a total of 200,000,000 arrobas (2,500,000 tons) of cane with a 19-roller milling plant, 37 in. × 84 in.

After trying repeatedly to find the causes of abnormal wear by closely observing the corrugations formed on the surface of the trash-plate, we concluded that many of them were caused by defective operation of the grinding plant and others by improper settings. Some of the principal conditions having to do with these abnormalities were as follows :—

(1) Irregular feeding due to insufficient levelling in the cane carrier. (2) Use of a crusher with rollers longer than those of the mill unit. (3) Inadequate distribution of the cush-cush from the maceration chokeless pumps over the bagasse blanket. (4) Improper mill settings, especially height of turnplates and relation between it and mill inlets and outlets.

Abnormalities which prevent the free floating of the top roll and contribute in part to make the wear on the turnplate irregular and the pressures ineffective, may be stated as follows :—

Deficient hydraulic rams ; crown wheels working out of pitch ; worn-out coupling-boxes and an impoverished square condition of coupling-spindles ; worn-out mill housing and top-roll brasses permitting excessive lateral movements ; excess clearance at flanges, incorrect diameter, or other defective mechanical details, and rolls and turnplates made of inadequate materials.

While the tests were being made, we noticed that the height of the turnplates and the proportions between the inlet and outlet openings of the mill (important items in the settings, also), have a direct bearing upon its performance. If incorrect, several difficulties will arise, as choking and defective feeding. These, in turn, may cause continuous movements in the hydraulics, generating vibrations and causing unnecessary efforts and wear. What is worse, these oscillations produce alterations in the top rolls of the grinding units ; as the lifts are not uniform at both ends of the roll in any of the existing types of mills, even those with differential pressure hydraulic arms, the losses by re-absorption increase. The same is true when there is lack of effective pressures, as will be explained in the second part of this work.

With the purpose of obtaining data on settings, during the last few years we have compiled figures on what we have called the Low Factor, which is the difference in height between the turnplate and top

[1] *Proceedings of the 13th Conference of the Association of Sugar Technologists of Cuba*, pp. 39-48.

roll and the real feed mill opening. From different experiments we have found the L.F. (Fig. 1) as most appropriate for our grinding plant at "Senado"; but this does not necessarily mean that its use in other tandems, where the thickness of blanket and grade of disintegration are different to ours, is equally applicable. In mentioning the word "blanket," we refer to arrobas of fibre per hour per sq. ft. of roll surface per minute.

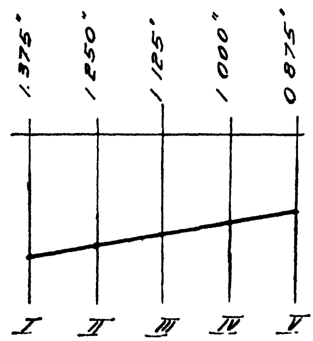

Fig. 1.

With reference to Fig. 2, A is the opening from point to point of grooving; B height of turnplate at the feed side of mill; C height of turnplate at the discharge side of mill; D depth of grooving in feed roll; and E depth of grooving in top roll.

Here is an elementary formula to obtain the height of turnplates, by applying the Low Factor to which we have referred, after finding the approximate heights which may cause the least amount of wear:

$$\text{Real Mill Opening} = A + \frac{E}{2} + \frac{D}{2}$$

$$\text{Height of } B = A + \frac{E}{2} + \frac{D}{2} + \text{L.F.}$$

$$\text{Height of } C = B + \frac{1}{2}$$

Since the juice cannot flow from a lower to a higher pressure zone, re-absorption can take place only: (1) By helical grooves and by the unevenness and imperfections of the roll surface; (2) by Messchaert grooves in the feed discharge roll of the last mill; (3) by excess of clearance between the flanges of the top and lateral rolls; and (4) by the impossibility of maintaining the top roll floating in horizontal position, due to mechanical irregularities, to fluctuations in the fibre, or to lack of proper settings.

In regard to these causes of re-absorption and lack of effective pressures, the following remarks may be made:—

(1) Helical grooves have been eliminated by the use of feed rolls. (2) The only Messchaert grooves used in the front of feed rolls are of an indispensable character. (3) The clearance between lateral rolls, central turnplate and top roll flanges, is $\frac{1}{16}$ in. on

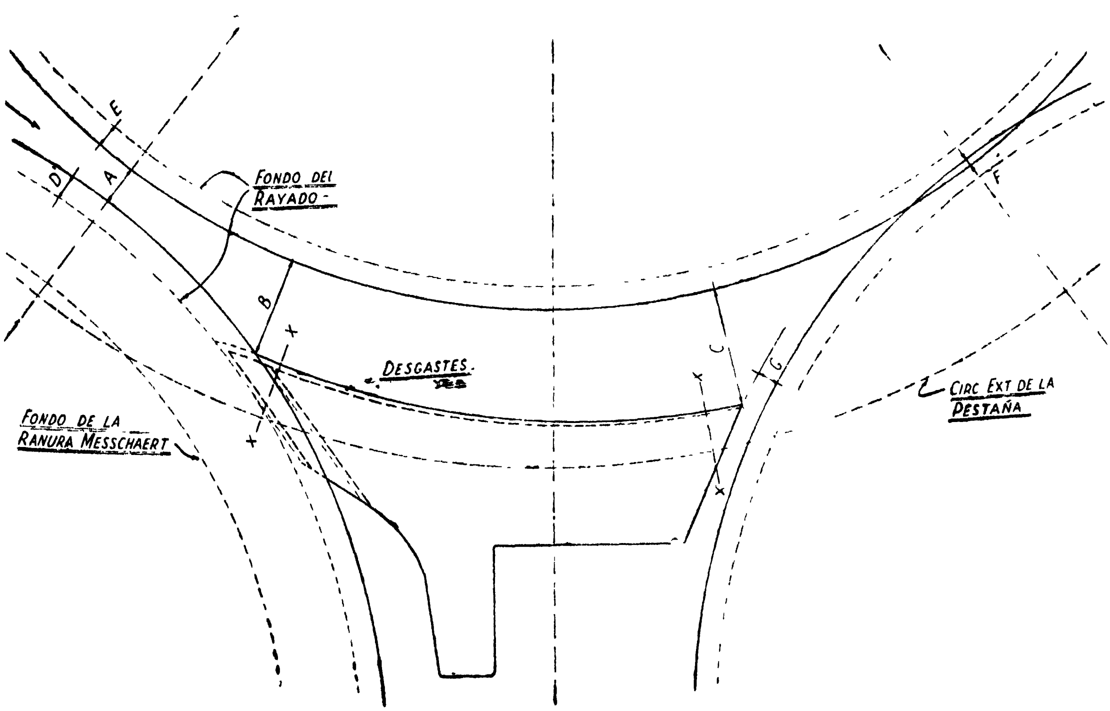

Fig. 2.

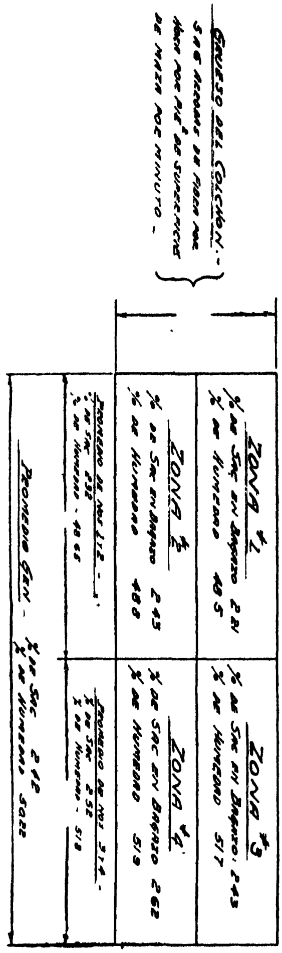
Grueso del Colchon.-
5.46 arrobas de fibra por hora por pie² de superficie de maza por minuto.
Zona #1
% de Sac en Bagazo 2 21
% de Humedad 48 5
Zona #3
% de Sac en Bagazo: 2 43
% de Humedad 51 7
Zona #2
% de Sac en Bagazo 2 43
% de Humedad 48 8
Zona #4
% de Sac en Bagazo 2 62
% de Humedad 51 9
Promedio de Nos 1 y 2.-
% de Sac 2 32
% de Humedad - 48 65
Promedio de Nos 3 y 4.-
% de Sac 2 52
% de Humedad - 51 8
Promedio Gen. - % de Sac 2 42
% de Humedad 50 22

Fig 4

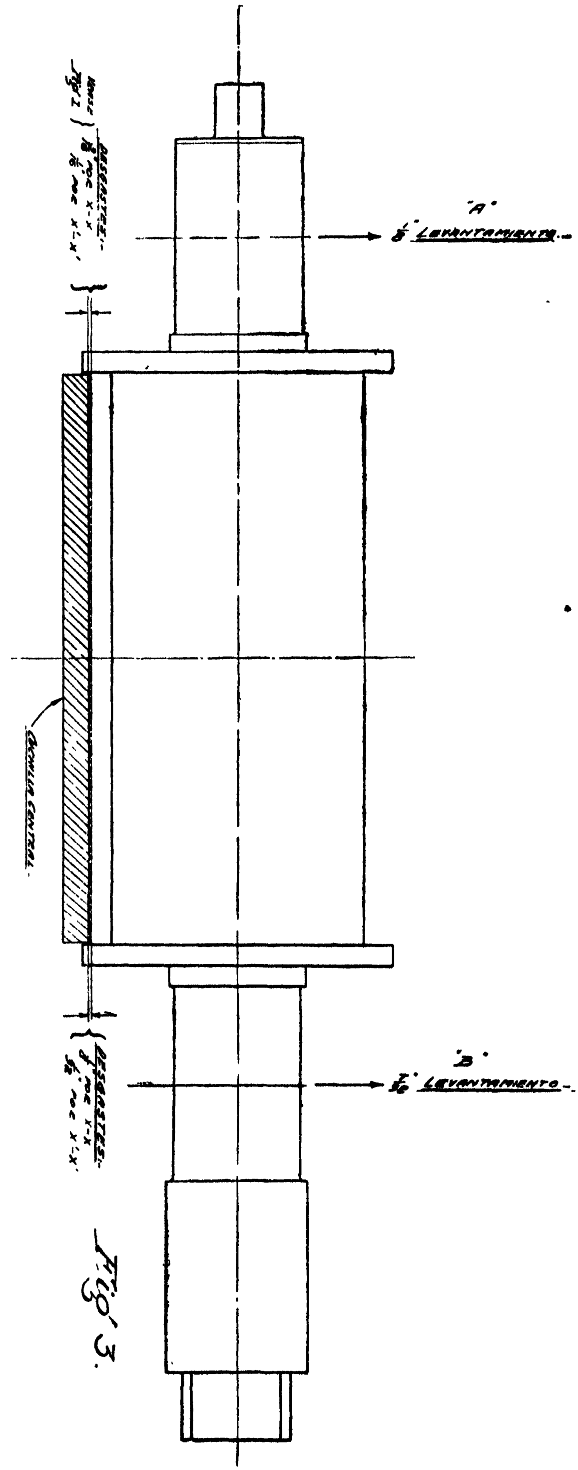
"A"
Levantamiento
Desgastes:-
por X-X
por X'-X'
Vease Fig 1
Cuchilla central.
"B"
Levantamiento
Desgastes:-
por X-X
por X'-X'

Fig 3.

each side; this is possible, due to the fact that maximum lift at both ends of top roll never exceeds $\frac{1}{4}$ in. (4) Every possible effort was made to eliminate the abnormalities preventing the free floating performance of the top rolls; double-guide hydraulic rams with ample areas were prepared to counter-check crown-wheel strains; pressure centres on top rolls were distributed so as to exert a compensating reaction in connexion with the resulting pressure; all efforts were directed towards operating crown-wheels as closely to the ideal pitch as possible; contacts between top half of top roll brasses and head-stock were kept properly adjusted and working well lubricated.

Tests Made.

The tests made are the average of 56 trials on bagasse sucrose and moisture. To check the lift of the top roll ends, we designed a device which has been installed permanently at the top cap of each housing in every mill. We assume that re-absorption in any extractable juice returning to the bagasse after passing the maximum pressure zones in the mill, as well as (though incorrectly applied) losses in the bagasse from lack of effective pressures.

Then, as juice flows from a higher to a lower pressure zone, when examining the results in Fig. 4, it will be noted that the figures of analysis by zone, correspond to the lifts in the top roll and to the wear on the turnplate.

Fig. 3.—Top Roll Lift: End A, $\frac{1}{8}$ in.; and End B, $\times \frac{7}{32}$ in. Turnplate Surface Wear: End A, $\frac{3}{16}$ in. by Section X—X and $\frac{1}{16}$ in. by X'—X' End B, $\frac{1}{8}$ in. by Section X—X and $\frac{1}{32}$ in. by X'—X'.

It may be observed that wear increases in the higher pressure zones, and keeps in about even proportion with the lifts.

Fig. 4.—Zones 1 and 2 correspond to End A, where we have less lift; therefore, these are high pressure zones. Zones 3 and 4 correspond to End B, where it may be noted there are more lifts; consequently, these are low pressure zones.

No explainable account can be offered by the author for the figures being lower in Zones 2 and 4; but it may be due to the effect produced by the dilutions, which seem to be more effective on the bagasse blanket surface.

Analysing the different zones in the bagasse blanket, the following results may be noted:—

(1) The averages in Zones 1 and 2 may well be assumed as the proper figures to obtain the theoretically extractable juice, for they are low lifting zones, and, consequently, of higher pressure. (2) If the average for the four zones is taken to estimate the actual extractable juice, then the theoretically extractable juice, minus the actual extractable juice, is equal to the losses by the re-absorptions.

In other words, if we deduct the actually extractable juice from the theoretically extractable juice corresponding to a certain lift in the top roll (such as those of averages in Zones 1 and 2), we obtain the amount of juices lost by re-absorption.

Applying these facts we can express the same idea by the use of the following formula to determine the losses by re-absorption and lack of effective pressures using the data shown in Fig. 4:—

T = Figures for the amount of theoretically extractable juice from Zones 1 and 2 or high pressure zones. P = Figures for the amount of theoretically extractable juice from Zones 3 and 4 or low pressure zones. JE = Actual extractable juice. R = Losses by re-absorption.

Then we have $JE = \dfrac{T + P}{2}$ (average for the actual extractable juice).

$R = P - T$ (losses by re-absorption).

Therefore, e.g., the losses by re-absorption and lack of effective pressures are:—

Per cent. of Sucrose in Bagasse:—

P = Average of Zones Nos. 3 and 4 ..	2·52
T = Average of Zones Nos. 1 and 2 ..	2·32
Losses	0·20

Moisture:—

P = Average of Zones Nos. 3 and 4 ..	51·80
T = Average of Zones Nos. 1 and 2 ..	48·65
Losses..............	3·15

Conclusions.— The conventional type of Rousselot mill has always given rise to serious difficulties in accomplishing good work; but, in spite of that, if properly taken care of, and if certain improvements are judiciously incorporated in it, its grinding efficiency can be increased to a considerable extent. The cost of the improvements referred to is insignificant and their application becomes worth while.

However, at Central Senado, after having extended all available resources to reduce losses by re-absorption and lack of effective pressures, and regardless of the efforts exerted and results obtained, we are still far from feeling satisfied. During recent years we have followed with enthusiasm E. W. Kopke's endeavours to develop the constant pressure mill.

H. J. B. Scharnberg's roll top bearing truss block tends to eliminate friction between the top roll bearings and the working side of the mill housing and can be considered as one of the most important contributions during the past few years towards free top roll movement to obtain greater effective pressures.

Japanese 1940-41 Crop Estimates.—Production of sugar in Japan, during the current season, is not now expected to reach the earlier forecast of 1,176,000 tons made some months ago, owing to the occurrence of damage in Formosa. The latest estimate, according to Lamborn, gives a figure of 1,102,000 long tons, or the smallest crop in six years, that is since 1935-36 when 1,090,000 tons was harvested. Since, however, sugar rationing is now in force in Japan, the output envisaged should suffice for the consumption needs.

The Oliver Filter in South Africa.[1]

The Oliver Campbell filter has now been in operation in some South African factories for several seasons, and the Filtration Committee has thought it timely to investigate the impressions of its value as a saver of labour, filter-cloth, steam, and also its upkeep and off-seasonal overhaul.

Questionnaires were directed to factories known to have installed the filter. Much useful information has now been collected. It was not the purpose of this enquiry to delve into financial comparisons of the Oliver filter versus the plate-and-frame press.

Its purpose is rather to enquire into operating methods and conditions and so acquire further knowledge that should lead to increased factory recovery, apart from the saving in sucrose on the by-product, and a general betterment in factory conditions. An extract of some of the questions and the replies thereto is given in the table herewith.

All filters are of standard diameter with varying lengths to suit the area. Unfortunately the size of the screen panels is not standardized, and it will be interesting to see how a new installation fitted with 9 ft. panels of copper screening will stand up to the wear-and-tear.

The stainless steel screen is now replacing the copper screen. One factory has supplied data showing a high loss of weight of copper screen after two months' immersion, as against no loss in weight for stainless steel.

The drum speed is a matter of special interest. It would appear as if in some factories the speed was governed by the amount of muds on hand. The variations recorded are wide, viz., from 1 revolution in 2 mins. 20 secs. to 1 in 4 mins.

In a very interesting report on the working of the Oliver filter, G. H. JENKINS[2] is emphatic on the necessity for slow speeds, 1 revolution in 6 to 8 mins. being recommended. Stress is laid upon low drum speed as a factor in the separation of the so-called cloudy and clear filtrates.

Bound up with this question of drum speed and its effect on the clarity of the second filtrate juice, is the question of the ample supply and size of bagasse particles.

Only two of the replies give ideas of the quantities of bagasse available, but the size of the screen and the size of the mesh do not seem to follow any standardized rule. In this connexion JENKINS[3] is instructive when he advises, *inter alia*, that the use of bagasse screens of eight holes to the inch gave a considerable increase of fine bagasse (or *bagacillo*) in the feed, resulting in a substantial improvement in the mud retention figure. Low drum speeds were found to assist the retention of muds in a marked degree, the effective separation of clear and cloudy filtrates being facilitated thereby.

Now, one would imagine that a dominant factor in judging the efficiency of any mechanical filter would be the amount of mud solids it can abstract in one operation. It is therefore disappointing to find, in almost all cases, both the filtrates go back to factory process, even to the sulphur tower. The first filtrate must necessarily be muddy and therefore must be re-processed, but is there to be no method of operation whereby the second filtrate may be separated and merged with the juices going to the settling tanks for decantation and thence to the evaporator supply ?

It is obvious that this mud retention figure (that is, the ratio of fibre to mud solids in the feed and in the cake, assuming that all the fibre is retained in the cake) is an all-important matter, since it is a measuring of the efficient abstraction of muds from the juice.

One condition for a high mud retention figure is an ample supply of bagasse of the correct size and size distribution. Large particles, whilst rendering the cake porous, pass through too great an amount of muds and lessen the efficiency of the wash-water. We must remember that the actual filtering medium, as in the plate press, is the mud itself which is deposited on the layer of bagasse, which, in turn, is supported by the screen. Hence the bagasse particles should bear some size relationship to the screen holes.

At this point it is well to enquire whether a contributory factor to good filter work does not lie in the better control of juice preparation, to obtain a well-formed granular precipitate. It can readily be imagined that, less mud re-circulation, quicker filtration and less wash water required to reduce the polarization of the cake, would be the normal consequence of such a precipitate.

With bagasse suitable in size and ample for the requirements, a low drum speed and a temperature of 190°F. minimum, it would appear that we have most of the conditions necessary for good mud retention on the filter pack.

One point requiring mention is the deterioration or decomposition that occurs in the filter trough ; the presence of H_2S is believed to be the result of the drop in temperature ; but may be assisted by the continuous circulation of re-heated muds. Decomposition evidently cannot be attributed to foul conditions ; in most factories a 12-hourly cleaning down is a routine job.

It is also to be noticed that there is an appreciable drop in purity between the clarified juice and the filtrates. One factory reports no increase in the reducing sugar ratio, but what about the destruction of dissolved dry substance ? The drop in the second filtrate can be more readily understood. Perhaps this drop in purity is the result of the washing back of

1 *Proceedings of the 15th Congress of the South African Sugar Technologists' Association* (here abridged). 2 *I.S.J.*, 1940, p. 385-387. 3 *Loc. cit.*

non-sugars, which may be facilitated by the presence of a large supply of over-size bagasse particles in the pack.

Few factories have exercised much control over the quantities of wash-water employed, the quantity of which should be governed by the economical limit capable of being handled at the evaporator, although it is difficult to say at what point the water actually displaces the juice in the mud pack and where it re-dissolves some of the non-sugars direct into the filtrate.

Records available show that one factory applying as much as 100 per cent. water on cake obtained 0·3 per cent. polarization, whilst a second applying half that amount of water obtained 0·4 per cent. polarization in cake.

It is a debatable point whether the efficiency of the filter may be reckoned by the lowness of the polarization of the cake, and to regard, say, 0·2 per cent. polarization of cake as a fine achievement, whilst neglecting the purity of the filtrate and the amount of muds returned for re-circulation into the juice.

Many interesting points have come to light that may have some bearing on the successful operation of the filter. One factory reports a variation in the quality of the *bagacillo*. On occasions it is found that it simply floats and will not mix with the mud in the feeding tank. This behaviour has been attributed to certain cane varieties. It is not, however, an experience common to the mills.

Stored *bagacillo* has a tendency to ferment, especially under conditions favourable to fermentation, and it can, of course, be readily understood that such material and the muds from stale and/or fermented cane are not good material for filter work.

The Committee was unable to secure much data on the saving of chemicals directly due to the installation of the Oliver filter. There is, however, a definite drop in consumption. As the amount of dilution of muds is less, resulting in a diminished volume of juices returned for re-treatment with chemicals, the saving must be significant in normal times.

The elimination of aforetime heavy dilution of filter-press muds must also show a diminished draw on the process steam, even allowing for the continuous re-heating of the muddy juices to be filtered. Only one factory ventured to cost out the savings in terms of coal and the figure was encouraging.

This report has already made brief reference to the upkeep and maintenance aspect of the Oliver filter. The overhaul of the plant has in some instances provided big problems. Corrosion of essential parts, excessive wear-and-tear on fittings, heavy depreciation on piping, etc., are common experience.

Abrasion in the *bagacillo* supply pipe, in the fan itself and in the cyclone, necessitating the fitting of rubber padding, the difficulties of getting rid of the sand in the trough and generally a more rapid and efficient method of cleaning, to mention but a few, are matters of vital importance and all make up quite a respectable contra account to the gains associated with the installation of the Oliver filter.

EXTRACT FROM REPLIES TO QUESTIONNAIRE.

	1	2	3	4	5
Tons cane crushed per hour	63	130	52	41	48
Size of filter, sq. ft.	(8 × 16) = 400	3 (8 × 12) = 900	(8 × 12) = 300	(8 × 12) = 300	(8 × 16) = 400
Sq. ft. filter area / Tons cane crushed per hour	6·33	6·92	5·76	7·41	8·33
Screen material	Copper	Stainless steel	Stainless steel	Stainless steel	Stainless steel
Bagasse screen, sq. ft.	120	75	35	48	120
Sq. ft. of screen / Tons cane crushed per hour	2·00	0·72	0·65	1·09	2·50
Mesh size	40	60	25	3/16″ hole special angle screen	36
Bagacillo per hour, lbs.	1,800	1,230	540	—	—
Bagacillo per ton of cane, lbs.	29	9·5	10 5	—	—
Drum speed	1 in 2½ to 4 mins.	1 in 2 mins. 20 secs.	1 in 4 mins.	—	—
Temperature of muds, °F.	185	200	185	205 to 212	175 to 180
Temperature of wash-water, °F.	105	170	160	180	104 to 115
Trough is cleared	Weekly	Daily also at every opportunity.	Weekly	12-hourly	—
Deterioration in trough	Yes	No	If temp. drops	Yes	Yes
Rise in cake per cent. cane	4·28 to 5·70	3·15 to 4·15	4·20 to 5·20	4·00 to 5·50	2·95 to 3·04
Pol. of cake	0·27	0·70	0·40	0·35	0·30
Disposal of first filtrate	Secondary juice	All mixed with second and returned to to juice tempering tanks.			Process Settling tanks
Disposal of second filtrate	Primary juice				
Drop in purity filtrate from clarified juice	3°	2·2°	3 to 4°	—	—
Estimated increase on factory recovery due to lower pol. in cake	1·0 per cent.	0·7 per cent.	0·54 per cent.	—	0·50 per cent.

A Mill *versus* A Shredder.[1]

By D. W. W. HENDRY.

Results prior to and after the addition of a fifth mill followed by a shredder to the Maidstone tandem, and a shredder followed by a fifth mill to the tandem of the Tongaat Sugar Co., Ltd., over a period of eight years, may enlighten the sceptical.

Maidstone Tandem.

During the off-season 1934-35 a fifth mill (36 in. × 84 in.) was added to the tandem. The second and third mills were considerably strengthened by replacing them by headstocks of cast steel after the 1935 season. The first and fourth mills were also strengthened in the same way for the 1940 season.

A Searby shredder was installed between the first and second mills during the 1937-38 off-season. For the 1937-38 season the grooving of the rolls was increased, for example, the first mill now has 2-inch pitch.

As will be observed from Table I, comparing the mill work during 1933-40, there has been considerable increase in the extraction.

For 1936 and 1937 the average extraction of 92·06 per cent. was 0·96 per cent. above the average of the seasons 1933, 1934 and 1935, which was 91·10 per cent. This increase is due to the work of the fifth mill.

In a somewhat similar manner, we now subtract from the average extraction for the years 1938, 1939 and 1940, viz., 93·74 per cent., the average for the years 1936 and 1937. This gives an increase in extraction of 1·68 per cent., due to the installation of the shredder.

To make allowance for the difference in fibre, the extraction has been calculated at an arbitrary figure of 12·5 per cent. The additional extraction resulting from the fifth mill and the shredder now becomes 0·63 per cent. and 1·28 per cent. respectively.

Tongaat Tandem.

The first Searby shredder was installed by the Tongaat Sugar Co., Ltd., for the 1937 crop, and was placed between the crusher and the first mill. Previously there were two crushers in this tandem, but one was removed to make room for the shredder.

During the 1935-36 off-season the mill headstocks were strengthened by exchanging them for ones of cast-steel. In a manner somewhat similar to the Maidstone tandem, the grooving of the rolls was increased in pitch.

Table I.—Maidstone Mill.

	1933	1934	1935	1936	1937	1938	1939	1940
Cane crushed per hour	55·89	58·33	62·44	60·70	61·15	61·84	64·28	63·33
Fibre per cent. cane	15·27	15·28	15·04	14·84	15·01	14·26	14·38	15·51
Maceration per cent. cane	32·52	31·93	30·15	33·46	31·48	31·32	28·31	29·51
Mill extraction	91·19	91·47	90·65	91·61	92·51	93·99	93·74	93·49
Extraction prior to fifth mill and shredder addition		91·10		—			—	
Extraction prior to shredder addition		—		92·06			—	
Extraction after shredder addition		—		—			93·74	
Per cent. increase due to fifth mill		—		0·96			—	
Per cent. increase due to shredder		—		—			1·68	
Extraction at 12·5 per cent. fibre	93·01	93·24	92·45	93·12	93·94	94·84	94·67	94·93
Extraction prior to fifth mill and shredder addition		92·90		—			—	
Extraction prior to shredder addition		—		93·53			—	
Extraction after shredder addition		—		—			94·81	
Per cent. increase due to fifth mill		—		0·63			—	
Per cent. increase due to shredder		—		—			1·28	

Table II.—Tongaat Mill.

	1933	1934	1935	1936	1937	1938	1939	1940
Cane crushed per hour	56·06	62·17	62·03	64·49	64·23	63·84	64·53	67·43
Fibre per cent. cane	15·27	15·28	15·04	14·84	15·01	14·26	14·38	15·51
Maceration per cent. cane	32·52	31·93	30·15	33·46	31·48	29·16	28·31	29·51
Mill extraction	91·28	91·27	89·93	89·55	91·35	92·39	93·83	93·30
Extraction prior to shredder and fifth mill addition		90·51		—			—	
Extraction prior to shredder addition		—		91·87			—	
Extraction after fifth mill addition		—		—			93·56	
Per cent. increase due to shredder		—		1·36			—	
Per cent. increase due to fifth mill		—		—			1·69	
Extraction at 12·5 per cent. fibre	93·09	93·08	91·87	91·43	93·00	93·20	94·75	94·80
Extraction prior to shredder and fifth mill addition		92·47		—			—	
Extraction prior to shredder addition		—		93·10			—	
Extraction after fifth mill addition		—		—			94·78	
Per cent. increase due to shredder		—		0·63			—	
Per cent. increase due to fifth mill		—		—			1·68	

[1] *Proceedings of the 15th Congress of the South African Sugar Technologists' Association.*

A fifth mill, with rolls 36 in. × 66 in., was installed during the off-season 1938-39. It must also be stated that from the latter period (off-season 1938-39) feeder rolls were installed to certain mills on both tandems, and these have done much to ensure a regular feed to the individual mills.

The remarks applied to the Maidstone tandem are likewise applicable to the Tongaat installation.

If we determine the increase in extraction due to the shredder and fifth mill separately, by subtracting the average extraction for the seasons 1933, 1934, 1935 and 1936 from the average for the seasons 1937 and 1938, and the latter from the average for 1939 and 1940, we get 1·36 per cent. and 1·69 per cent. respectively for the shredder and fifth mill additions.

To make allowance for the difference in fibre, the extraction has been calculated at 12·5 per cent. fibre. The increase for the shredder now appears as 0·63 per cent. and 1·68 per cent. for the mill.

Chemical Reports and Laboratory Methods.

Mill Control, and the Effect of the Primary Juice Figure. H. J. N. MAX. *Archief Suikerind. Nederl.-Indië*, 1940, **1**, pp. 272-275.

Among the different factors exerting influence on the mill control figures, the determination of the value of the primary juice demands special attention. Quite small differences in it result in considerable variations in the value of the juice content of the cane. It is of course erroneous to assume that it has the same composition as the "cane juice," as is done for the calculation of certain control data. Below are given average figures for Brix, pol. and purity of crusher and of primary juices :—

	Brix.	Pol.	Purity.
Crusher juice (*crs.*)	18·66	16·22	86·92
Primary juice (*vps.*)	18·48	15·99	86·53

By the primary juice is understood the total juice of the crusher and first mill, which together with the secondary juices form the raw juice. It is seen that the analysis of the primary juice as usually determined differs from that of the first expressed juice, its figures being somewhat lower. Hence, the question arises as to the value to be taken as mostly exactly representing the cane juice.

Figures depending on this answer can be divided into two groups : (1) Those calculated entirely from the Brix figures, as the juice content of cane, also the lost juice in bagasse per cent. fibre, and the Brix-free (colloidal) cane water, per cent. fibre ; and (2) those calculated from the sugar content or purity quotient, as the ERQV and available primary juice factor.

In the table below comparisons are made of these figures as based on analyses of crusher juice (*crs.*) and of primary juice (*vps.*), average figures being given here :—

	crs.	*vps.*
Juice content of cane	89·2	83·7
Lost juice in bagasse, per cent fibre	41·0	42·0
Brix-free (colloidal) cane water, per cent. fibre	25·0	19·0
Juice in cane, per cent. fibre	608·0	614·0
Available primary juice factor	73·7	74·9

It is seen that though the lost juice and the juice in cane per cent. fibre figures show only quite small differences, on the other hand the differences in the Brix-free (colloidal) cane water, per cent. fibre are marked.

Also, from the sugar content of the primary juice are calculated control figures, such as the ERQV and the available primary juice factor. How these values compare when calculated from the *crs* and the *vps* are shown below, the ERQV being obtained from the value :—

$$\frac{1{\cdot}4 \times \text{purity raw juice} - 40}{1{\cdot}4 \times \text{purity primary juice} - 40}$$

	crs.	*vps.*
ERQV	95·4	96·1
Available primary juice factor	73·7	74·9

If primary juices are expressed from the cane in fractions, and these used for the calculation of various control figures, the differences are naturally accentuated, as is seen from the following, BWQ being the Brix recovery quotient :—

Primary Juice.	BWQ/ *vps.*	Juice content.	Purity.	ERQV.
1st fraction	40·9	84·9	92·7	94·7
1st and 2nd fractions	59·8	84·8	91·8	96·1
1st, 2nd and 3rd fractions	75·0	84·9	90·9	97·3

Wood as a Chemical Raw Product in Sugar and Alcohol Production. DAVID BROWNLIE. *Chemistry and Industry*, 1940, **59**, pp. 671-675.

An outline is given of the developments in the U.S. and in Germany in the use of wood (by cellulose hydrolysis) for the production of sugars, which may possibly be utilized as foodstuffs or fermented to alcohol by means of yeast. For example, mention is made of the Simonson and Classen processes in Germany, and of the work done by the E. I. du Pont de Nemours Co., at Georgetown, U.S.A., and by the U.S. Forest Products Laboratory at Madison, Wisconsin.

The net result of these trials in Germany and the U.S.A. is to show that the average yield of sugars

obtained varies between 18 and 30 per cent., calculated on the air-dried wood. About 65 to 75 per cent. of the complicated mixture of sugars obtained (depending on the species of the wood and the method of hydrolysis) is fermentable, whilst the remaining 25 to 35 per cent. can be used for cattle food. The average yield of alcohol is 15 to 22 Imp. gall. per metric ton, also on the air-dried wood.

Then there are the Bergius and Scholler processes, stated to be in commercial operation in Germany, for which the yields of alcohol obtained are higher than previously obtained in Germany and in the U.S. Thus in the Bergius process the yield of alcohol is claimed to be 85 to 90 Imp. gall., and in the Scholler 63·5 Imp. gall. per long ton of wood. Of the total sugars about 20 per cent. is unfermentable, and can be used as fodder. In 1935 the Rheinau plant of the Bergius process was enlarged to produce 6000 tons of sugar per annum, and the combined production of alcohol in 1936 by the three Scholler plants was over 100,000 hl. of alcohol.

But even if these German claims are correct, and all the technical problems have been solved, including blackening of the sugar, and severe wear and tear of the plant due to corrosion, it is difficult to imagine how the production of sugar and alcohol from wood can be regarded as a commercial proposition in normal times. Sugars can be produced much cheaper directly from sugar cane and beet, and also by the hydrolysis of starch from potatoes and other natural products, a valuable method also because of the great extra reserve of emergency food made available.

Besides, there are the sugars available in waste wood pulp liquors, the commercial utilization of which is an unsolved technical problem. These liquors would yield from 15 to 16 gall. of alcohol per metric ton of pulp. Then in the "Masonite" process of manufacturing a fine fibrous product by "exploding" wood by treating it with high pressure steam and releasing to atmospheric pressure, there are available a large amount of sugars (hexosans and pentosans) produced by the hydrolysis of the hemi-celluloses and ligno-celluloses. This method of treating wood gives results superior to the ordinary methods of hydrolysing pentosans with dilute acid at 50 lbs. per sq. in., besides being much cheaper.

Inversion of Sucrose in the different Parts of the Sugar Cane Stalk. J. I. LAURITZEN and R. T. BALCH.[1] *Journal of Agricultural Research*, 1940, **61**, pp. 1-16.

In Louisiana, as in many temperature zone and some torrid zone sugar-producing countries, the cane never reaches maturity. If the stalk as prepared for the mill is cut into three equal lengths, and each analysed separately, it will be found that there is a considerable gradient in sucrose content from the top to the middle to the bottom section, the smallest amount being in the top third, and the largest in the bottom one. As a rule, the difference is greater between the top and middle thirds than between the middle and bottom thirds. There is also an obvious difference in the vegetative condition of the tissues of these three parts.

It is a matter of some interest to determine what bearing, if any, this difference in sucrose content and vegetative condition has on the inversion of sucrose in the harvested cane. To this end, five experiments were carried out at Houma, La., during 1932-1936, in which whole-stalk samples and one-third-stalk samples from the same lots of cane (POJ 36-M and Co 290) were placed in storage. In the first two experiments the samples were stored under controlled conditions of temperature and humidity, and in the remainder they were kept under dry conditions in the shade in an open shed.

Here is a summary of the conclusions arrived at as the results of these extensive experiments : There was less inversion of sucrose in all samples stored at high relative humidities than in corresponding samples stored at low r.h. In general, the rate of inversion of sucrose was correlated with the rate of loss of moisture. In most instances there was more total loss of moisture and inversion of sucrose from the three sections in samples cut before storage than in samples sectioned after storage. Exceptions seemed to be due to the lack of uniform exposure of samples to the evaporating power of the air.

In cane stored as whole stalks, there tended to be a gradient in the percentage of loss of moisture, increase in Brix, drop in purity and loss of sucrose. These changes were greatest in the top, next in the middle, and least in the bottom section. In cane cut before storage, this gradient was disarranged so that these changes tended to be greater in the top and bottom sections than in the middle section.

In the experiments in which POJ 36-M was used, there was greater inversion in the unsevered top third of the stalks than in the severed top third. On the contrary, during the early periods of storage there was greater inversion in the severed bottom third than in the unsevered bottom third with the difference decreasing and sometimes disappearing with lapse of time. Co 290 behaved similarly, except that the differences were not so marked, and after the first period of storage there was a decrease in the difference in the top sections instead of in the bottom ones.

Correlated with these trends of inversion of sucrose in the top and bottom third sections of the sugar cane stalk was a greater loss of moisture and increase in Brix in the top third of cane stored as whole stalks than in the top third stored as sections and in the bottom third of cane stored as sections than in the bottom third stored as whole stalks. Because of the difference in concentration of sucrose in the different

[1] U.S. Department of Agriculture.

parts of the sugar cane stalk the actual loss of sucrose may not correspond to the rate of loss. It is only when the rate is much greater in the sections with the lower concentrations that these sections show the greatest loss of sucrose.

Solubility of Sucrose in Organic Solvents.[1] G. VERHAAR. *Archief Suikerind. Nederl.-Indie*, 1940, **1**, No. 18, pp. 464-475.—In a previous paper the author reviewed the literature on the solubility of sucrose in water, giving also some of his own determinations, and he now summarizes briefly what is recorded of the solubility of sucrose in methyl alcohol, ethyl alcohol, acetic acid, glycerin and acetone, the last mentioned solvent being specially considered, and his own determinations made with it presented. Actually the solubility of sucrose in acetone is slight, but on adding acetone to a solution of sucrose in water a certain amount enters into solution until at a certain concentration the liquid begins to turn cloudy, separation taking place. The author's determinations concern the solubility of sucrose in mixtures of water and acetone of different proportions, and from his figures the following conclusions are drawn : (1) The quantity of water per cent. total mixture (sucrose-water-acetone) up to the point at which the separation of the solvent takes place remains practically constant. (2) The quantity of sucrose per cent. water which is soluble in the water present in the mixture decreases as the concentration of acetone increases. (3) This decrease on the sucrose content, expressed as a percentage of the solvents (water and acetone) is directly proportional to the concentration of acetone. The connexion between the sucrose content and the acetone concentration up to the point at which separation takes place is given by : $S = 216{\cdot}46 - 3{\cdot}1\,x$, in which S is the sucrose per cent. solvents (water-acetone); and x is the acetone per cent. by weight of the mixture. In an example, where x is 20·21, S is 154·4 as directly determined, and 153·81 as calculated by the formula. A phase diagram based on the author's determinations has been drawn by him for sucrose-water-acetone mixtures at 30°C.

Synthetic Glycerin from Petroleum. E. C. WILLIAMS and ASSOCIATES. *Chemical and Metallurgical Engineering*, 1940, **47**, pp. 834-838.—In a process experimentally operated in a pilot plant by chemists of the Shell Development Co., of Emeryville, Cal., U.S.A., a line of synthesis was chosen starting with propylene and proceeding to allyl chloride (or to glycerin dichlorohydrin), and thence finally to glycerin. It was the discovery of the "hot chlorination" of propylene that made the process practicable. A crude glycerin results which is concentrated and purified in much the same way as in the working of soap lyes, and by extracting with xylene or other solvent a product is obtained conforming to all commercial specifications. A yield of about 90 per cent. is obtained.

Determination of Levulose in the Presence of Dextrose and Levulose, using Ferricyanide. H. C. BECKER and D. T. ENGLIS.[2] *Ind. & Eng. Chem.* (analy. ed.), 1941, **13**, pp. 15-18.—This is a continuation of the work previously reported[3] on the selective oxidation of levulose in the presence of dextrose and sucrose, the reagent used being : potassium ferricyanide, 50 grms. ; disodium phosphate dodecahydrate, 225 grms. ; and sodium carbonate, anh., 150 grms. per litre. This reagent is allowed to react at 50°C. for 60 min. Dextrose exerts a small but definite reducing reaction, and a factor is introduced to correct for its presence ; but sucrose has very little effect. When levulose is present to the extent of 20 per cent. of the total reducing sugars, an average accuracy of 0·5 per cent. can be obtained, but when the proportion is less the error increases rapidly.

Determination of B.O.D. in Waste Waters. O. R. PLACAK and C. C. RUCHHOFT.[4] *Ind. & Eng. Chem.* (analy. ed.), 1941, **13**, pp. 12-15.—For the determination of the biochemical oxygen demand in pollution studies, the azide and the Rideal-Stewart modifications of the Winkler method are equally efficacious. Either may be expected to give reliable results. The azide reagent may be added in a preliminary step following acid, or it may be added in combination with the alkaline-iodide Winkler reagent, the latter method having manipulative advantages for routine work.

Adoption of 20°C. as Standard Temperature in Raw Sugar Polarizations in Cuba. M. A. MASCARÓ. *Proc. 13th Conf. Assoc. Sugar Tech. Cuba*, pp. 219-223.—Object of this paper is to urge that Cuba should adopt 20°C. as the standard temperature in commercial raw sugar transactions. It is explained that in that country between 9 a.m. and 6 p.m. at the time of year during which the greatest volume of sugar sales is effected the average room temperature in most laboratories is 30°C., and that this increase of temperature above 20°C. is capable of causing a difference in polarization of 0·3°. This is a serious divergence. For example, a raw sugar the polarization of which is not carried out at 20°C., or is not corrected to that standard temperature, and is reported as 95·7° instead of 96° at 20°C. is depreciated in a sale of 100,000 bags at 2 cents per lb. to the extent of $3,120. In view of such losses, it is advocated that the Association of Cuban Sugar Producers should install a constant temperature laboratory, the cost of which would be about **$6,000** ; and that in other laboratories the prevailing temperature corrections, the accuracy of which has been officially proven, should be officially adopted.

1 This completes the author's research on the solubility of sucrose, the first part of which was recently published, *I.S.J.*, 1941, pp. 50-52.
2 University of Illinois, Urbana, Ill. 3 *I.S.J.*, 1939, p. 316.
4 U.S. Public Health Service, Stream Pollution Investigations' Station, Cincinnati, Ohio.

Abstracts of the International Society of Sugar Cane Technologists.

Under the scheme initiated by the International Society, a collection of abstracts of papers on agricultural and technical subjects is prepared monthly. A selection from these "Sugar Abstracts" has been made by us from the material last issued, and is printed below.

Cane Agriculture.

Fibre in Cane Variety Co 290. J. Rochade Almeida and R. Canseglieri. *Jornal de Agronomia* (Sao Paulo), 1940, **3**, No. 3, pp. 221-238 (with four plates).

The fibre contents of various parts of the cane variety Co 290 as grown in Sao Paulo are found to be as follows :—

	Maximum.	Minimum.	Average.
Roots	80·00	60·13	69·165
Whole Cane	17·80	12·70	13·971
Nodes	24·00	17·80	19·188
Internodes	12·70	10·20	11·372
Leaves	39·40	32·50	35·660
Infloresence	77·00	40·80	60·645

The proportions of fibre in various parts (thirds) of the stripped stalk are :—

	Maximum.	Minimum.	Average.
Whole Cane—			
Top	14·00	9·20	11·165
Middle	15·10	10·40	12·743
Foot	20·00	13·79	15·138
Medulla (pith)—			
Top	11·00	7·00	7·968
Middle	9·00	7·50	8·264
Foot	10·00	8·00	9·385
Rind—			
Top	34·20	19·40	25·468
Middle	33·80	24·60	29·246
Foot	38·70	27·60	32·335

Within the maximum and minimum limits here given the fibre of Co 290 varies directly with the age of the cane (plant crop), and in ratoons with the number of harvests. The fibre of plant canes (stalks) varies from 9·6 per cent. at 11 months to 14·8 per cent. at 20 months. In ratoon crops, the fibre rises from an average of 12·67 per cent. in plant canes at the usual harvest time to 12·85 in the first and 13·22 per cent. in the second ratoon crop

Stools that have flowered contain distinctly more fibre than non-flowering ones. As shown by the analyses, the fibre increases from the foot of the stalk towards the top, in the nodes as well as in the internodes. On the whole, Co 290 is to be regarded as a variety with a fair amount of fibre, although it contains somewhat less than POJ 213 as grown in Sao Paulo (Usina Vassununga).

Does Fertilizer affect the Arrowing of Cane ? H. W. Kerr. *Cane Growers' Quarterly Bulletin* (Queensland), 1940, **8**, No. 2, p. 76.

Inspection of a field that had received various fertilizer treatments showed that the percentage of arrowing was abnormally high on some of the plots, and that this difference had some relation to the differences in fertilizer treatment. Counts were therefore carried out and figures obtained in respect of the individual fertilizer treatments.

The results showed that where the cane received no sulphate of ammonia fertilizer the percentage of arrowed stalks was 71, where 200 lbs. sulphate of ammonia per acre had been applied, the percentage of arrowing was 54, and where 400 lbs. sulphate of ammonia had been used, the percentage was only 11.

These figures illustrate strikingly the influence of sulphate of ammonia on the degree of arrowing of the crop, and emphasize the importance of applications of the correct manures in the correct proportions for best results. A stalk which has arrowed can make no further growth (except by "sideshooting"), no matter how favourable the growing conditions may be.

In a favourable spring season, unarrowed stalks may take advantage of beneficial growing conditions until they are harvested. Varying amounts of phosphate and potash were also included in the experiment referred to, but these plant foods appear to be without influence on arrowing.

Varietal Resistance to Cane Grubs. R. W. Mungomery and J. H. Buzzacott. *Australian Sugar Journal*, 1940, **32**, No. 6, pp. 325-326.

A variety of cane may be resistant to damage by soil grubs for several reasons. In the first place, much depends on the character of the root system (i.e., whether surface or deep); bulk of roots is important, but power to reproduce roots rapidly after root-pruning is more so. Again, certain canes prove resistant to grubs by virtue of the fact that they attract fewer ovipositing beetles because they either have a sparse top and offer less cover, or they show less early vigour and are shorter when the beetles are flying. On the other hand, a long stalk and a very heavy top tends to lever the basal portion of the stool out of the ground long before all the roots have been destroyed.

Recent examinations have revealed that, under conditions of moderate infestation, POJ 2725 is very resistant to grub attack and shows neither uprooting nor withering of the top. POJ 2878 shows less resistance than POJ 2725 but considerably more resistance than Badila, Korpi, or Oramboo, which latter three must be classed as susceptible varieties. POJ 2878 showed considerable uprooting and much

dead tissue in tops in all plots examined, but many of the stools were still attached to the ground by a few roots and the variety had made much more cane than Badila or Korpi, of which the roots were more or less completely severed.

When reviewing these results, it must be taken into consideration that varieties may not behave in the same way every year or in different types of soil. For instance, this particular year was very wet in the area where these observations were made, the soil in most cases had a fairly high clay content, and the grubs were for most of the season located near the surface. Under these conditions of attack the roots had been completely eaten through not far below the surface. Under dryer conditions, when grubs would be located deeper in the ground, a variety with a large but shallow rooting system might have sustained less damage. The resistance shown by POJ 2725 seems to warrant a trial of this variety in grubby areas.

Sugar Cane Varieties in Florida. B. A. Bourne. *Facts About Sugar*, 1940, **35**, No. 12, pp. 23-27.

The experimental work of the Agricultural Research Department of the United States Sugar Corporation at Clewiston, Florida, is outlined. Prominent in this work is the search for cane varieties best suited for the soil and climate of the region (the Everglades). The variety heretofore mostly used has been POJ 2725, but this is now giving way to F 31-346, which has these characteristics :—

It shows a greater resistance to cold damage, and to the Helminthosporium leaf disease ; it is especially adapted to the raw saw-grass muck soils which heretofore have been considered unsuitable for cane culture ; it has a very thick barrel, which makes it easy to harvest by hand. F 31-346 is cold resistant not only as to leaves and growing points, but even after a hard freeze its juices do not deteriorate as rapidly as those of other canes.

Labour Saving Machinery. E. R. Theriot and E. A. Maier. *Louisiana Cane Sugar Technologists' Association*, Thibodaux, La., June, 1940.

The mule-powered scraper is not much used now in the cane fields. A good substitute has been found in a power-driven rotary scraper or shaver attached to a tractor which will take care of a heavy cover of winter grass or legume ; with this tool the cane can be scraped in January before any ploughing has been done, so that the cane can get an early start. Two men can shave 25 acres a day at a cost of 13 cents an acre.

Hand hoeing, which costs \$1·25 to 1·75 an acre, can now be done by the Herbert or the Longerman hoeing machine (which also does off-barring) at a cost of 55 cents an acre. The quality of the work done by these mechanical devices is not up to that of good hand hoeing, but this disadvantage is probably more than compensated by the much lower cost and by the fact that the scraping and off-barring can be done in the winter to give the cane crop an early start. On the whole, the machines have given satisfactory results.

Producer Gas and Charcoal. Queensland Producer Gas Committee, *Bulletin No.* 1 (1940).

This official document lists six Australian firms that manufacture producer gas engines ("Gasogens") suitable for the operation of trucks. These outfits have been officially tested and approved. The outfits are intended for use with 1½ or 2-ton trucks costing around \$750.

Results of tests, method of operation, and detailed operating expenses are given. It is found that with these engines 13 to 16 pounds of charcoal are equivalent to one gallon of gasoline. Under Australian conditions a tractor working 10 hours a day for four days a week will cost \$8·80 to 11·20 to operate with charcoal, or \$23·40 with kerosene fuel. The saving of \$12·20 to 14·60 a week is thus considerable.

It is said that the operation of a producer gas-powered vehicle is easily learned and presents no special difficulty. Somewhat more time is required for daily servicing of the engine than where gasoline is used for fuel. The best charcoal for this use is that made from dense, heavy woods.

Beet Technology.

Predefecation in Various Practical Forms. M. Nitzsche. *Centr. Zuckerind*, 1940, **48**, No. 37, pp. 655-657 ; No. 38, pp. 669-670.

The history and development of the pre-liming or pre-defecation process is sketched from Kowalski and Kozakowski in 1901 down to the most recent work of Troje and Puschmann. These latter have demonstrated the necessity of working to and keeping within the optimum *pH* of 10·7 and 10·9. Below this optimum some colloids are not flocculated ; above it, some colloids already precipitated are redissolved and are not reprecipitated when the *pH* is again brought back to the optimum limit

Control of the operation with indicator paper suffers from subjective inaccuracy and should be replaced by an electrolytic control by an "Ionometer." However, by holding the pre-limed juice for several minutes at the optimum *pH* (which has not been overpassed in the pre-liming operation) the precipitated colloids become "stabilized" and are not reprecipitated when the *pH* is raised in the subsequent main liming.

One of the main requirements for success of the pre-liming process is avoidance of local over-liming, and this requires equipment for good agitation and practically instantaneous mixing of the milk-of-lime with the raw diffusion juice. Several types of such equipment used in German factories are described. It is also advantageous to do the pre-liming in stages,

or at least at a slow rate that will allow sufficient time for the reactions.

Even while the pre-liming process was being developed as a preliminary to the main liming operation, the idea arose of dispensing with the main liming and simply filtering and carbonatating the pre-limed juice. This idea grew out of the fact that the small amount of lime uesd in the pre-liming operation is of itself sufficient to coagulate all the precipitable impurities. The function of the main liming is merely to make the precipitate more easily filtered. But the difficulty here was that the precipitate produced in pre-liming is hard to filter with the ordinary filtering equipment.

Two processes for getting around this difficulty have come under notice. One is to carry out the pre-liming as usual with 0·2 to 0·25 per cent. CaO, warm to 90°C., and stir in 0·1 per cent. superphosphate; then the juice is raised to 115°C. for a short time, cooled again to 100°C., and then sent through the filter presses under a somewhat higher pressure than usual. After carbonatation and sulphuring a very good sugar was obtained, although the lime content of the juice was somewhat increased.

The other tentative process is to pre-lime the raw juice as usual and add some "Collactivit" (previously neutralized with milk-of-lime); the pre-liming is followed by an addition of 0·3 per cent. CaO on beets, and this is followed by carbonatation and filtering over the base-exchanging material "Durasit" for removing the last traces of lime. This process is not exactly a "main-liming-less" defecation process, but it is at least an approach to it.

The advantages offered by a "main-liming-less" defecation process are such that efforts to achieve it undoubtedly will continue. These advantages will include a saving of lime, and what is of equal or greater importance, will ease the difficulty of getting rid of the piles of filter-press mud that each year accumulate on the premises of a beet sugar factory. A third advantage lies in a reduced consumption of filter-cloth.

Re-use of Filter-Press Muds. O. Spengler and W. Dorfeldt. *Zeitsch. Wirtsch. Zuckerind.*, 1940, **90**, No. 9-10, pp. 356-391.

The investigation took the form of a comparison of the use of lime of good quality on the one hand and lime consisting of regenerated (re-burnt) press mud on the other hand. The results are succinctly reported in the following statements :—

(1) The filtration of first carbonatation juice in the experiments with regenerated mud was not as good as in the control experiments.

(2) The alkalinity of the first carbonatation juice (tested with thymolphthalein paper) was the same in all the experiments.

(3) The thick-juices showed no differences in purity. There was no evidence that the regenerated mud had affected the ash content, the organic non-sugar content, or the organic coefficient of the thick-juices.

(4) The composition of the ash of the thick-juices showed no appreciable differences; in particular there was no appreciable increase of the alkali components of the ash.

The general result is to show that one return of regenerated mud to the juice purification has no undesirable result except in the fitration of the first carbonatation juice. Since this work was done in May with beets of very poor quality, the results might be different with good quality roots.

Rapid Determination of Water in Syrup and Molasses. C. Nobili. *Industria Saccarifera Italiana*, 1940, **33**, No. 9, pp. 307–311.

The determination of moisture in a concentrated sugar product by the drying method has the inconvenience of requiring a long time (8 to 10 hours) for reaching a constant weight. In the common method a small quantity of the syrup or molasses (2 to 3 grms.) is mixed with a relatively large quantity (30 to 40 grms.) of quartz sand. The substance is thus spread over a large free surface, but still the drying action is slow. Owing to the small amount of the sample, the result is less precise than it would be if a larger sample could be taken.

In place of quartz sand the author uses fossil flour (kieselguhr, diatomaceous earth) as the spreading medium, in the proportion 2·5 grms. to 5 or 6 grms. of the sugar product. These proportions are such that the mixture is friable and shows neither lumps nor paste. When the sample thus prepared is placed in a vacuum dryer at 95°C. constant weight is reached in about 1 hr. 45 mins.

The fossil flour must be well dried before use. It is very light, and precaution must be taken to prevent loss by dusting when it is being handled. The mixing should be quite thorough, which, in the case of very stiff products, will be facilitated by a little dilution with known amounts of water. The results show good agreement and are less erratic than is often observed when quartz sand is used.

Keeping Quality of Affined (Beet) Sugar. K. Sandera. *Listy Cukrovar.*, **58**, No. 53-54, pp. 321-324; *Deut. Zuckerind.*, 1940, pp. 657-658.

Experiments were made to determine whether a raw beet sugar factory could deliver to the refinery an affined sugar (98 purity) that could be dissolved directly as a refinery syrup, thus removing affination from the refinery routine. This is possible in two ways: the raw sugar factory may use high-speed centrifugals to obtain a well-dried sugar, or it may pay much more attention to the careful boiling and ripening of the massecuites. For storing this affined sugar it is essential to keep the moisture content under 2 per cent. A very good keeping quality was obtained by giving the sugar a final washing in the centrifugal with water having an alkalinity of 1 per cent.

Brevities.

THE LATE H. J. B. SCHARNBERG.—This well-known engineer who died recently, was Superintendent of the Clewiston sugar-house, in the Florida Everglades, during the last nine years of his life. The efficient results realized today are attributed by the management of that concern to be "in a large measure the fruits of his genius, skill and untiring devotion." Some of his inventions related to heavy duty cane knives ; a cane mill having boltless housings and free floating top roll; a sugar "homogenizer" and mechanical circulator.

THE NEW ORDER.[1]—"The basic characteristics of this New Order are beginning to emerge with increasing clarity in the discussions of thoughtful men everywhere. Most of them are agreed that it must guarantee freedom of thought, of speech, of movement, of worship, to all men; it must establish the rule of law both nationally and internationally; it must recognize the State, not as an all-powerful "Super-being," but as an instrument of public welfare and of cultural development; it must organize the means of production and of distribution for raising standards of living and of working for all the peoples of the world."

LOUISIANA IN 1940.—The sugar crop in Louisiana in 1940, according to Willett & Gray, was the smallest since 1933 when production was 209,000 tons. It amounted to 235,000 short tons or only 54 per cent. of the 1939 production which was 434,000 tons, and 82 per cent. of the ten-year average. This was due to an unusually adverse growing season, the weather being for the most part extremely variable, with cold and warm spells, drought, storm and floods. The number of factories grinding in Louisiana was 65. On the other hand, weather conditions were generally favourable in Florida and a record crop of just over 100,000 short tons was achieved.

AMERICAN SUGAR REFINING COMPANY.—The net income of the "American" in 1940 from all sources after federal taxation and depreciation was $3,444,680, which compares with $2,771,058 in 1939 and $407,088 in 1938. The year was more favourable to the Company than was 1939, the improvement being attributed principally to a more stabilized price for sugar and to slightly wider refining margin. The favourable results in the United States more than offset the less favourable ones of the Company's Cuban Corporation, which had a net loss of $192,496, as compared with a net profit of $287,757 in 1939. During the last few years the Cuban Corporation has written off each year for depreciation a sum of $600,000.

A NATAL BEREAVEMENT.—A cable to hand from South Africa brings us news of the death in April of Mr. Robert Armstrong, the Managing Director of the central factory situated near Verulam, Natal. This factory, originally established some 65 years ago, has seen a fifty-fold development since it first started, for it began with an annual output of some 300 tons of sugar and now turns out over 18,000 tons. About 1893 Mr. W. G. Armstrong became sole owner and carried on the business till 1925 with the assistance of his brother, Mr. Robert Armstrong. Subsequently the latter succeeded to the property, which he carried on with the help of his three sons as a private company. In more recent times the business was turned into a limited company, under the name of Central Factory Ltd., Umdhloti Junction, with Mr. Robert Armstrong as Managing Director.

JAVA 1940-41 SUGAR CROP.—According to the Nivas, the final figures for the Java 1940-41 sugar crop show that the total reached 1,605,057 metric tons.

WATER-SOFTENING AND JUICE CLARIFICATION.—In a paper recently read before the Queensland Society of Sugar Cane Technologists, the lime-soda process of boiler feed-water treatment was discussed, and the application of experience gained with such methods to juice clarification in the cane sugar factory was considered. It was pointed out that in water purification the removal of impurities was about 80 per cent., but only about 17 per cent. in the case of juice. Possible means of improving clarification (an account of which will be given later) were also suggested.

THE PHILIPPINE QUOTA IN U.S.A.—Last April the Sugar Division at Washington re-allotted to various countries a deficit of 73,232 short tons, raw value, in the Philippine sugar quota, the chief beneficiaries being Dominican Republic, Nicaragua, Peru and Salvador. This deficit represents the difference between the 1941 Philippine sugar quota of 1,055,895 short tons, raw value, established under the Sugar Act of 1937 and the amount of sugar which may be admitted free of duty in the U.S.A. from the P.I. under the Philippine Independence Act. This amount is the equivalent of approximately 982,660 short tons, raw value. The deficit quantity if imported from the Philippines would have to pay full duty.

U.S. QUOTAS FOR 1941.—The second revision of the U.S. Sugar Quotas for 1941 (the original estimate being made last December[2]) was issued in April, the figures being as follows, in tons, raw value :—

	Short Tons	Long Tons
U.S. Beet	1,589,100	1,418,839
Louisiana and Florida	430,794	384,638
Hawaii	961,764	858,718
Puerto Rico	818,166	730,505
Virgin Islands	9,141	8,162
Philippines	982,663	877,377
Cuba	1,959,947	1,749,953
Foreign (full duty)	100,314	89,566
	6,851,889	6,117,758

SHIPPING PHILIPPINE SUGARS.—According to the Philippine Sugar Association there is a good deal of anxiety in P.I. sugar circles as to the availability of shipping space, even at the prevailing high freight rate of $19 per ton of sugar. The fear is that national defence demands on American shipping will markedly reduce the availability of ships to transport the Philippine sugar to the U.S.A. On the other hand, shipping circles in Manila while admitting that space on vessels was tight did not agree that there was an actual shortage of bottoms, and thought that conditions might improve in the near future, providing Japan is not involved in the war. Sailings in 1940 were not much behind those of 1939, and up to the end of January last 214,000 tons of raw sugar was shipped to the U.S.A., as against 137,000 tons in the like period a year previously. There is however an abnormal demand for space for shipping mineral ores, due to the war demand, the quantity having almost doubled. It is however thought that the U.S. maritime commission will give preference to sugar in the cargo priority plan.

[1] From the address by Dr. JOHN V. N. DORR on receipt of the Perkin Medal at a meeting of the American Section of the Society of Chemical Industry, January, 1941.

[2] See *I.S.J.*, 1941, p. 39.

Sugar-House Practice.

Capacity Figures for the different Stations of (Cuban) Sugar Factories. F. A. LOPEZ FERRER. *Proc. 13th Conf. Assoc. Cane Sugar Tech. Cuba*, pp. 235-243.

Averages for the capacity of the different units of the cane sugar factory are admittedly to be regarded with some reserve, as a number of factors enter into their compilation, of which full account is not always taken. Not the least of these is the nature of the cane being ground, and the manner in which the particular piece of plant is operated, that is the personal element. In this article the author ventures to suggest figures for ratings based on theoretical formulae, but confirmed by practical results obtained by him in his long experience of Cuban conditions.

Mills.—At the 11th Conference of the Cuban Association, the author proposed the following formula for determining the capacity T in tons of cane per hour :

$$\frac{3{\cdot}1416 \times D \times L \times R \times A \times 1620}{F \times 2000}$$

in which D is the diam. of the top roll in ft.; L, the length of the roll in ft.; R, the revs. per hour of the roll; A, the opening (blanket thickness) in ft.; and F is the fibre per cent. It applies to the rolls of the first mill, and to tandems equipped with revolving knives. Where such are not in use, a reduction of 15 per cent. in capacity should be made.

Boiler Plant.—It is hardly possible to give a general formula for the boiler capacity, as there are so many factors entering into the problem, and one has to have recourse to average figures. More than 60 factories (in Cuba) have an average of 331·2 sq. ft. of h.s. per ton of cane per hour, minimum figures being 269 to 288 and maxima around 384·4. Probably a rate of 288 would be about right.

Clarifiers.—In the case of decantation tanks (cylindrical or rectangular), the recommended capacity is 90 cub. ft. per ton of Crystalina or similar cane per hour, which figure must of course be increased when the juice of POJ and like canes are being treated. In the case of continuous clarifiers, e.g., Dorrs, 14 years ago their capacity was 64·3 for the primary and 35·9 for the secondary per ton of cane per hour; but since then, due to the introduction of POJ and like varieties, the figures (according to Miguel de Arango) are 89·9 and 47·4 respectively.

Juice-heaters.—S, the sq. ft. of surface of copper tubes may be found from the formula :

$$\frac{P\,C\,(t'' - t')}{K\,(t''' - t')}$$

where P is the lbs. of juice to be heated, C, its sp. ht.; t', the temperature of the entering juice; t'', that of the heated juice; t''', that of the heating steam; and K the heat transmission coefficient in B.T.U. an average figure which can be taken safely being 130. In terms of weight of cane this formula gives 14·5 to 15·4 sq. ft. of h.s. per ton of cane hour.

Evaporators.—S is the sq. ft. of h.s. of the evaporator $= \dfrac{P\left(1 - \dfrac{B}{B_1}\right)}{M}$ where P is the weight of the juice to be evaporated in lbs. per hour; B, the Brix of the raw juice; B_1, that of the syrup produced; and M is a constant, 7·5 for a triple, 6·5 for a quadruple, and 5·5 for a quintuple. Steam consumption in lbs. of steam per 100 of juice may be expressed by the following formula, as applied to the evaporation of juice at 18° Brix to 60° in a triple and a quadruple, knowing that 1 lb. of steam in single effect will evaporate 0·95 lbs. of water :—

$$\frac{100\left(1 - \frac{18}{60}\right)}{2{\cdot}85} = 24{\cdot}56; \quad \frac{100\left(1 - \frac{18}{60}\right)}{3{\cdot}80} = 18{\cdot}42$$

lbs. of steam per 100 of juice.

Pans and Crystallizers.—Pan capacity depends greatly on technical handling, pan design, etc., but a fair figure for capacity is 38·4 cub. ft. ton of cane per hour, and 1·80 sq. ft. of h.s. per cub. ft. of volume. Crystallizer capacity may be taken as 24 for 1st and 19·2 cub. ft. for 1st and 2nd strikes per ton of cane per hour, and when 2nd sugars are added to the 1st m.c., the figures may be taken as 28·8 and 19·2. Third m.c. should have a capacity of about 164 when the purity of the juice is around 84.

Centrifugals.—In the machines for 1st and 2nd sugars the total capacity required is 85·44 sq. in. of 400 perforations per sq. in. per ton of cane per hour; and for 3rds, 211·2 sq. in. of 576 or 625 perforations. Hence, in the case of a factory grinding 3562 tons cane per day four machines will be required for the 1st sugars, the same number for the second, and say ten for the 3rds.

The Cail Continuous Crystallizer. R. WEIL. *Proc. 13th Conf. Assoc. Tech. Cuba*, pp. 129-131.

This consists of a tank of parallelopipedous shape divided into a number of transverse compartments by means of permanent walls consisting of hollow spaces through which flows cooling water in countercurrent to the masseucite as it passes by gravity from one compartment to the next. The outer surfaces to the compartment walls are subjected continuously to the action of a scraping device having at the same time a stirring effect. It consists of a number of paddles joined to one another to form a kind of grill, which hangs to an exterior shaft, and is operated by means of an eccentric.

In this manner the paddles are subjected to a lateral push by the massecuite, which forces them towards the compartment walls during filling and

diverts them while discharging. At the same time the paddles receive a rotary motion from the eccentric. These two movements combined are effective in eliminating sugar crusts as they are formed on the cooling surfaces, and in rendering the massecuite homogeneous during the cooling process.

As the mechanism operating the cleaning device is located apart from the massecuite under treatment, its supervision is facilitated. In many types of crystallizers, the cooling surfaces are allowed to extend beyond the body of the massecuite with the result that crusts of sugar form on them. These two important objections are eliminated in the Cail design of crystallizer.

It is claimed that this crystallizer meets all the requirements which a continuous apparatus should have. It assures rapid cooling without the formation of false grain ; it gives a homogeneous massecuite ; it realizes the maximum exhaustion of the mother-liquor ; it allows of the incorporation of diluting syrups with proper control of the supersaturation ; it consumes a relatively low power (from 3 to 3·5 H.P. per 70 to 75 hl. of massecuite) ; and finally it really operates continuously without the necessity of stopping at intervals for cleanings and adjustments. For an effective volume of 320 hl., the cooling surface is 175 sq. m.

In a 2000 ton beet sugar factory in France, it has been found possible entirely to eliminate the return to the vacuum pans of the molasses from the first massecuites. In this way the purity of the massecuite can be dropped from 90 to 72°, and its temperature can be lowered from 65 to 45°C. in three hours, the water used entering at 30 and leaving at 55°C. It is normally built for a capacity of 320 hl., and a cooling surface of 175 sq. metres, that is a ratio of cooling surface to capacity of 1·8.

Separate Clarification of High and Low Purity Mill Juices. J. G. SALINAS. *Proc. 13th Conf. Assoc. Cuban Sugar Tech.*, pp. 165-172.

This article discusses the clarification difficulties with which the factory superintendent is confronted as the result of the refractory nature of the juices resulting from the grinding of seedling canes, POJ in particular, and the means which have been proposed for dealing with them. He recommends the separate clarification of the first or *A* juices and the last or *B* juices.

Juice *A* after being discharged from the heaters at a temperature of 103°C. passes through a mixing tank to a liming tank, where its temperature is held at 65 to 70°C. There it is limed with saccharate to 6·6 to 6·8 *pH*, after which after heating to 103°C. the liming is completed in a mixing tank below by adding a further quantity of saccharate to give a reaction of 7·6 to 8·0 *pH*.

Juice *B* is treated in a similar manner, being discharged from the heaters at a temperature of 104 to 105°C. to give a temperature in the mixing tank of 70 to 75°C. with a reaction of 6·6 to 6·8 *pH* in the first liming phase and after heating to 104 to 105°C. 8·2 to 8·4 *pH* in the last one. In this treatment it is found that flocculation is adequate and the precipitation of impurities is satisfactory. Having thus been clarified, the juices *A* and *B* go to separate clarifiers.

Mud obtained from the two clarifiers differs considerably in its filtrability, *A* being superior to *B* by reason of its higher *bagacillo* content. In the operation of filtration, the first part of the charge is effected with *A* mud to form the first layer, after which it is filled in with *B* mud, aided by an addition of screened bagasse.

Emphasis is laid on adequate mill sanitation, which in fact is considered the "paramount condition for good clarification," any expense in the cleaning of the mills with compressed air, hot water and steam being economically reflected back into the process. A good quality of lime should also be used for the preparation of the saccharate of lime.

Use is made in the control of the process of a "quotient of clarification" expressed as :—

$$\frac{P_2O_5 \times 100^2}{\text{Brix (Brix - Total Sugars)}}$$

which should not be less than 10, based on a normal P_2O_5 content for the juices of 0·04 to 0·06 per cent. Tabulated results show that when mill sanitation was not practised, even when the P_2O_5 content of the juice was normal, the clarification was deficient according to this quotient which was in the neighbourhood of 8 to 10. Under "absolutely sterilized conditions," however, figures from 10 to 15 were reached.

Oil Removal from Exhaust Steam and Boiling-House Condensates. S. MOTT-SMITH. *Reports of the Hawaiian Sugar Technologists, 3rd Meeting*, pp. 107-111.

Oil exists in the exhaust from the mill engines and pumps in two stages : (1) globular and (2) emulsified. To deal with (1), the "Centrifix" apparatus was installed at the Puunene mill, Maui, Hawaii, in all the exhaust steam lines leading to the boiler house ; and (2) the "Permutit" system was applied to the boiling-house condensates. Promising results were obtained by means of these two methods of treatment, as is shown by the tabulated results shown below.

In the "Centrifix" apparatus use is made of centrifugal force as the means of separation. In outline it resembles a large sleeve placed in the exhaust steam line, on entering which the steam passes through a tuyère consisting of a number of radial blades set at a 45° angle, which imparts to it a vigorous whirling motion. As the result, the oil is thrown outward and carried along the inner surface of the sleeve until discharged through an annular slot into the outer concentric drain pocket. There are two distinct

separating stages, the first recovering the bulk of the entrainment, and the second acting as a refining stage.

As for the "Permutit" system, this employs a coagulent which entrains any free oil, and is later trapped in a filter-bed. Sulphate of alumina and soda ash are the reagents used for the production of the coagulent, e.g., aluminium hydroxide. These reagents are fed into the inlet of the filter manifold from pressure pots, making use of an orifice plate in the line to create a differential in pressure sufficient to force the water into the pots, the solution being displaced as it is fed into the line. Control of the rate of flow is accomplished by calibrated needle valves, and the pots when empty of solution are disconnected from the feed lines and charged from a tube located on top.

Sand is used as the filtering medium, aided by graded sizes of "Anthrafilt", and the time taken by each filter is about 30 min. Water for washing purposes is passed through the filter in the reverse direction of the treated water. Experiments were carried out to observe the relative merits of high and low pressure filtration. Below are given the average control figures for the amounts of oil separated by the two methods :

"*Centrifix*" *Apparatus.*

Condensate, lbs. per hour	2,660
Oil extracted in lbs. per hour	0·78
,, ,, per 24 hours	18·70
,, per cent. of that entering	70·00

"*Permutit*" *Filtering System.*

Condensate, thousands of lbs. per 24 hours	3,128
Oil entering, parts per million	2·250
Oil leaving ,, ,,	0·030
Oil extracted, lbs. per 24 hours	0·355

It was found that high pressure operation was superior to low, probably because of the better feeding of the reagents into the inlet manifold. Two complete "Permutit" filtering units are being installed for next crop, as the result of which it is believed that complete elimination of oil in the boiler feed water should result. After the water left, the "Permutit" filters had to receive corrective treatment to bring it to a suitable pH before going to the boilers.

Use of Yeast in the Manufacture of Invert Molasses.

ALLAN P. FOWLER. *Proc. 13th Conf. Assoc. Cane Sugar Tech. Cuba*, pp. 227-230.

In the manufacture of invert or high-test molasses, it is now generally conceded that for effecting inversion the use of the enzyme invertase present in yeast is preferable to that of hydrochloric, sulphuric or other acid. Guerrero's process, developed at Central Báguanos,[1] in which the necessary amount of yeast is built up at the factory from a pure culture is undoubtedly a step forward. But, due to the high cost of the installation, it seems unlikely that many mills will be able to adopt the procedure under present conditions. During the 1939 campaign most of the mills purchased the invertase yeast directly from the manufacturers.

At Central España it was decided to steer a course between adopting the Guerrero process and purchasing the completed invertase yeast, that is to say, a so-called stock yeast was bought from a yeast manufacturer and built up to from five to six times its original invertase content at the factory. Plant required included : an air filter, an air blower, an air washer, a cooler and two tanks equipped with air and water coils. All this equipment was made at the factory with the exception of the air blower, which was of the Root type. It was found that the best sugar material for the yeast growth was the defecated juice, due to the suitability of its composition and its sterility, though last mill juices or final molasses might have served equally well.

After well sterilizing the tank, 1500 gallons of a 6·5° Brix solution of defecated juice and water was introduced into it, the pH being adjusted to 4·5 with sulphuric acid, in addition to which some tricalcium phosphate and some nutrient salts were added, this mixture being cooled to 86°F. Stock yeast was prepared by adding 70 c.c. of sulphuric acid and 5 grms. of sodium hydrosulphite to a barrel containing 50 litres of water, the pH being adjusted to between 2·0 and 3·0 by the addition of a further amount of sulphuric acid, after which 50 lbs. of stock yeast (broken up with gloved hands) were well mixed into the contents of the barrel. It was allowed to stand for about an hour.

Turning again to the tank containing 1500 gallons of *musto*, agitation by bubbling in air was started (using in all at least 300 cub. ft. per min. for the 1500 gallons), and the contents of the barrel of stock yeast gradually added to it. In doing so, the temperature was kept between 82 and 91°F. and the pH between 4·0 and 4·8, adjusting with calcium carbonate when necessary. During the ensuing eight hours the Brix should drop from 6·5 to 0·7 °at a fairly uniform rate. Failure to do so indicates an insufficiency or irregularity of the air supply, lack of temperature or pH control, infection or other abnormal condition.

When the Brix has reached 0·7, the invertase in the yeast has increased five to six times its original quantity, and it is ready for addition to the syrup coming from the evaporator. This syrup should not be over 60° Brix nor over 140°F., and the milk-of-yeast is added to it at the rate of about 0·07 per cent. of the milk (containing about 60 per cent. moisture) on the sucrose present. As the result of the action of the invertase, the purity of the syrup will drop from 80 to 10 (apparent) in from 12 to 15 hours, equivalent to 60 to 70 per cent. of inversion. A saving of 50 per cent. in the cost of inverting materials resulted from using this method instead of purchasing the finished yeast.

[1] *I.S.J.*, 1940, pp. 258.

Stock Exchange Quotations of Sugar Company Shares.

LONDON.

Company	Quotation May 20th 1941	Quotation April 21st 1941	1941 Dealings Highest.	1941 Dealings Lowest.
Anglo-Ceylon & General Estates Co. (Ord. Stock)	24/0 — 25/6	24/0 — 25/6	25/3	24/6
Antigua Sugar Factory Ltd. (£1 Shares)	⅜ — ⅝	⅜ — ⅝	11/3	8/9
Booker Bros., McConnell & Co. Ltd. (£1 Shares)	2⅜ — 2⅝	2⅜ — 2⅝	52/6	47/6
Caroni Ltd. (2/0 Ord. Shares)	1/0 — 1/6	1/0 — 1/6	1/2¼	1/0
(6% Cum. Pref. £1 Shares)	21/9 — 22/9	21/9 — 22/9	22/6	20/3
Gledhow-Chaka's Kraal Sugar Co. Ltd. (£1 Shares)	$1\frac{3}{16}$ — $1\frac{5}{16}$	$1\frac{3}{16}$ — $1\frac{5}{16}$	24/6	22/0
Hulett, Sir J. L. & Sons Ltd. (£1 Shares)	24/3 — 25/3	24/6 — 25/9	26/0	22/1½
Incomati Estates Ltd. (£1 Shares)	$\frac{3}{16}$ — $\frac{5}{16}$	$\frac{3}{16}$ — $\frac{5}{16}$	—	—
Leach's Argentine Estates Ltd. (10/0 units of Stock)	5/9 — 6/3	6/0 — 6/6	6/6	5/9
Reynolds Bros. Ltd. (£1 Shares)	35/0 — 37/0	34/6 — 36/6	38/0	32/7½
St. Kitts (London) Sugar Factory Ltd. (£1 Shares)	1⅝ — 1⅞	1⅝ — 1⅞	—	—
Ste. Madeleine Sugar Co. Ltd. (Ordinary Stock)	13/0 — 14/0	13/6 — 14/6	14/3	11/9
Sena Sugar Estates Ltd. (10/0 Shares)	4/9 — 5/9	¼ — $\frac{5}{16}$	6/1½	5/0
Tate & Lyle Ltd. (£1 Shares)	49/9 — 50/9	48/3 — 49/3	50/9	46/0
Trinidad Sugar Estates Ltd. (Ord 5/0 units of Stock)	5/0 — 6/0	5/0 — 6/0	5/7½	5/0
United Molasses Co. Ltd. (6/8d. units of Stock)	23/7½ — 24/1½	22/3 — 22/9	25/1½	21/9

NEW YORK (Common Shares).†

Name of Stock.	Par Value	Closing Price May 9th, 1941.	1941. Highest for the Year.	1941. Lowest for the Year.
American Crystal Sugar Co.	No par	13	14½	9⅛
American Sugar Refining Co.	$100	16	19	13
Central Aguirre Associates	No par	16⅝	22¾	16¼
Cuban American Sugar Co.	$10	4¼	5¼	3½
Great Western Sugar Co.	No par	22⅞	26⅜	19⅞
South Puerto Rico Sugar Co.	No par	16¾	21	16⅛

† Quotations are in American dollars and fractions thereof

United States, All Ports.

(Willett & Gray)

	1941 Long Tons.	1940 Long Tons	1939 Long Tons
Total Receipts, January 1st to April 12th	1,302,478	1,120,201	1,141,892
Meltings by Refiners " "	1,254,032	1,044,653	1,074,688
Importers' Stock, April 12th	67,203	74,378	27,849
Refiners' Stock " "	247,938	437,739	239,337
Total Stock " "	315,141	512,117	267,186
	1940	1939	1928
Total Consumption for twelve months	5,712,587	5,648,513	5,604,051

Cuba.

(Willett & Gray)

	1941 Spanish Tons.	1940 Spanish Tons.	1939 Spanish Tons
Carry-over from previous crops	1,184,393	588,293	729,172
Less Sugar for Conversion to Molasses	57,661	— —	— —
	1,126,732	588,293	729,172
Production to April 12th	2,250,000	2,610,000	2,600,000
	3,376,732	3,198,293	3,329,172
Exports since January 1st	780,695	728,712	684,415
Stock (entire Island) April 12th	2,596,037	2,469,581	2,644,757

Centrals grinding, 49, *against* 60 *in* 1940, *and* 42 *in* 1939.

Brevities.

MAPLE SUGAR PRODUCTION IN U.S.A.—In 1940 there were over ten million maple trees in cultivation in the United States which produced 315 tons of sugar and 2,628,000 gallons of maple syrup.

JAVA 1940 SUGAR PRODUCTION.—According to Lamborn, sugar production in Java during 1940 amounted to 1,578,287 tons, as compared with 1,550,462 tons in 1939. The estimate for the 1941 crop is around 1,720,000 tons. Stocks on hand on January 1st, 1941, amounted to 918,310 long tons, which figure compares with 466,359 tons of January 1st, 1940. This increase in stocks is primarily due to decreased exports, the exportation in 1940 being 794,277 tons, compared with 1,347,780 tons in 1939.

CUBA'S ENGINEERING RESOURCES.—It is pointed out that Cuba's sugar mills, which remain idle nine months in the year, possess in their well-equipped engineering shops and trained personnel a source for turning out equipment for the Western Hemisphere defence service, such as would be easily transportable to nearby U.S.A. naval stations. Cuba also has a nascent mining industry which calls for more adequate development and at the present moment offers advantages for United States requirements owing to the short transit to the mainland.

BRITISH SUGAR CONTROL PURCHASES.—According to market reports, Britain has recently instigated negotiations for the acquisition of some 20,000 tons of Cuban sugar. But the U.K. authorities are believed to insist on payment in the form of registered sterling, while the Cuban exporters naturally want U.S. dollars, the traditional currency. But as the Cuban stocks of unsold sugar are inconveniently large, it can hardly suit them to refuse any offers of purchase owing to the mode of payment being different from the normal. It is also stated that the Ministry of Food has bought a moderate amount of San Domingo sugar through New York at the low price of 0·75 cent. per lb., f.o.b. The market also expects the Ministry will make further purchases of Java sugar, which would be paid for on a sterling basis.

EVAPORATOR LEVEL CONTROL.—J. L. Clayton in a recent communication to Queensland technologists (to be published later) stated that the large decreases in capacity which occur when an evaporator effect vessel is operated with an incorrect juice level may be practically eliminated by the installation of regulators. These are adjusted to maintain the juice levels at the optimum point, viz., approximately one-third of the way up the calandria.

ELECTRICAL DISTRIBUTION IN THE MILL.—R. L. George in a paper published lately in Queensland emphasized that the electrical distribution system throughout a mill is of great importance, though a side of the system which is inclined to be overlooked. Any lack of reliability in this direction can and will cause very great inconvenience through shutting down individual units. Money spent in providing a sound distribution system can be regarded as a very wise insurance policy.

SWITCHBOARD EQUIPMENT.—A. Coyle recently published a useful paper giving a list of the gear and instruments which should form part of the main A.C. switchboard equipment in the sugar factory, these including : a frequency meter ; a synchroscope, three ammeters ; two voltmeters ; an indicating kilowatt meter ; a kilowatt hour meter ; a power factor meter ; an oil switch ; an alternator field switch ; reverse power relays ; and current transformers. Some details of the specifications of these items will be given later.

MECHANICAL PAN CIRCULATION.—G. H. Jenkins, of the Bureau of Experiment Stations, Brisbane, recently discussed the shortcomings of natural circulation in vacuum pans. He concluded that for heavy low-grade strikes at least, mechanical circulation is necessary to give a reasonable rate of boiling under Queensland conditions and to avoid damage to the massecuite by local overheating. He also pointed out that in addition to the advantages mentioned pans so equipped open the way to better fuel economy by the use of low pressure vapours and the elimination of "movement water," and lead ultimately to an improved exhaustion of the molasses.

Sugar Crops of the World.

(*Willett & Gray's Estimates at Mid-April,* 1941.)

	1940-41 Long Tons.	1939-40. Long Tons.	1938-39. Long Tons.
CANE.			
America	8,281,245	8,770,194	8,583,167
Asia	8,251,400	8,423,879	7,773,478
Australasia	928,000	1,047,137	957,322
Africa	1,154,607	1,057,279	1,099,107
Europe	10,000	6,666	13,124
Total Cane	18,625,252	19,305,155	18,426,198
BEET.			
Europe	9,162,741	9,565,730	8,670,373
U.S.A.	1,575,353	1,472,216	1,501,587
Canada	95,350	75,573	63,883
Total Beet	10,833,444	11,113,519	10,235,843
TOTAL CANE AND BEET	29,458,696	30,418,674	28,662,041
Increase or decrease	—959,978	+1,756,633	—1,171,220

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Notes and Comments.

And Now Russia.

When in 1939 on the very eve of the war Germany concluded a surprise pact with Russia, HITLER declared in the Reichstag that war between the two countries "shall and will not happen again." But he had much earlier told his intimate colleagues that a temporary pact with Russia might be useful because it could be torn up when it suited him to do so. And this is what he did on the 22nd of June, breaking yet one more agreement when the opportune moment arrived. The German armies and their mechanized equipment and co-operating air forces, which have for months been massed on the eastern borders of Germany, have started to seize, if they can, yet another large section of the European continent. The battle is just joined as we write these lines, so all that can be said at the moment so far as the military operations are concerned is that Russia seems determined to fight the invader with all her powers ; how far she is prepared for the struggle is a matter that time alone will show. The Soviets have been so secretive for years past in respect to all their developments, both economic and military, that there is no certain knowledge as to the extent to which they have built up their defensive personnel and equipment. On the whole, military commentators seem impressed more with the quantity than with the quality of Russia's military machine. But in any event, this is no case of Germany attacking a small and weak country, but one of vast extent and very considerable resources ; in fact next to Great Britain, this may well prove the biggest proposition the Nazis have yet tackled.

The reasons for this typical piece of Nazi treachery towards another big Totalitarian Power must remain for the moment a matter of intelligent speculation. Two months ago, discussing the larger strategy in the Middle East, we mentioned the undoubted lure to Germany of the Russian oilfields on the Caspian and of the rich corn lands of the Ukraine. It may be, then, that HITLER has decided he must without delay replenish his oil supplies and refill his granaries before the German shortage of these two commodities becomes more marked. As regards grain, there seems plenty of evidence that the unusually cold weather of the first half of this year has affected mid-European agriculture and rendered it at least very backward. True, the Ukraine fields are not yet ready to reap and invasion has its dangers for them, but the invaders may argue it is better to secure the areas while the corn is still green than to risk a retreating Russian army firing all the ripe corn. Anyhow, both German and Rumanian armies are now invading the Ukraine and if they succeed in making headway, it is not a great distance to the Caspian oil centres. The invasion of Greece and the securing of air bases on the islands in the Ægean Sea, in particular in Crete, can now be seen as part of the strategy to isolate Russia, rather than as a preliminary to an immediate attack on Iraq, Palestine and Egypt. An eleventh hour friendly pact with Turkey, which the latter seems to have deemed an inevitable step if she was not to be dragged into the war this summer, was part and parcel of the German plans to avoid danger on their flanks. And the fact that our much too leisurely invasion of Syria has not been already countered by a German flying expedition seems to be accounted for solely because the German strategy was concentrating on the attack on Russia and deemed that it could afford to leave Syria alone for the moment. If Russia falls, the rest of the Middle East would not present much difficulty to the victorious German armies, or so they would argue.

But the present timing of the attack on Russia may well be dictated by larger considerations than the plunder of the Soviet supplies. The Germans have no illusions as to ultimate victory save by conquering Great Britain and their long mooted invasion of this island fortress has yet to be undertaken. But an intact Russia means that any concentration of Nazi forces on the west might give an opportunity for Russia to attack a depleted eastern border of Germany, and an attack by Russia has always been the supposed dread of the German Command, in that it would precipitate a war on two fronts. Better, the Command has evidently argued, knock out Russia

now, and then later on in the year England can be attacked with only a single front to consider; even if the attack on England cannot be started this year, a disabled Russia would greatly facilitate the conquest of the Middle East next autumn and winter when the weather is less tropical than during the summer. So Russia comes into the picture now, the Germans believing that Great Britain even with American aid will not be prepared to invade the Continent on the west before the Spring of 1942. If this belief proved correct, then British attack in the west must be confined to operations by aerial forces which, damaging as they undoubtedly are, serve more as a defensive tactic for the Allies than as any aggressive plan that will rid the occupied countries of their German garrisons. The real tussle will come only when the British forces feel strong enough to invade the Continent.

Britain's Attitude.

The standpoint of Great Britain, now that Russia is attacked, was succinctly expressed by Mr. CHURCHILL in a broadcast message. He said that no one had been a more persistent opponent of Communism than he for the past 25 years and he would unsay no word that he had spoken about it, but all this faded away before the spectacle which was now unfolding, for we had but one aim and that was to destroy HITLER and every vestige of the Nazi régime, so any man or State that fought against Nazism would have our aid. He therefore promised Russia that every possible help would be given her steadfastly to the end.

Naturally the steps that will be taken are the secret of the British Command; but what we actually do to aid Russia must remain contingent on the present extent of our equipment which we are steadily building up with the help of America for the day when we hope to seize the initiative of attack on Germany. At the same time, it seems obvious that the present opportunity is one we cannot afford to miss if it is humanly possible to take advantage of it. If Russia is ultimately knocked out, we are left alone with America to face the full force of the German might. If Russia keeps going, the struggle on two fronts—the German bugbear—will persist. It is therefore our duty to redouble our exertions without delay and make the most of the present chance that Germany may not have a walk-over in the East.

Mr. CHURCHILL did indicate one form of action on our part that could at once be applied in ever-increasing measure, and that was the heavier bombing of Germany and German-occupied territory by day as well as by night for, he said, from now henceforward the main expansion of our air force proceeded with gathering speed. In another six months the weight of the help we were receiving from the United States in war materials of all kinds and especially in heavy bombers would begin to tell. A welcome feature of recent summer days has been our ability to send over in daylight to France and at least fifty miles inland forces of bombers protected by fighters and the results have been reminiscent of the fights in the Battle of Britain last Autumn. Though fighting this time over hostile territory, we have maintained the old ascendancy and the German losses in aircraft if not in pilots have been in much the same proportion to ours as was the case last Autumn. So far these fights seem to have been feelers to gauge the extent of the R.A.F.'s capabilities, but the results seem to augur well for a much wider extension of the tactic.

The attack on Russia has naturally held the stage in the war news of late; but other features of recent occurrence deserve brief mention for record. The destruction of the *Bismarck*—which appears to have been crowded with a supernumerary crew learning to man the new ship prior to being drafted to later vessels—nipped in the bud a great danger to convoys on the Atlantic, as was proved by the subsequent capture of quite half a dozen supply ships waiting to replenish her needs as a commerce raider. The Germans did not risk one of the finest warships in the world save in the hope that she would work great destruction to shipping. In the Middle East we have proved strong enough to carry on two actions simultaneously, one in Syria and the other against the German forces at Sollum. Syria we have invaded with tactics so politically tempered to avoid French bloodshed that the man in the street could be pardoned for feeling apprehension lest the Germans stepped in ere we had half overcome French official resistance. At time of writing it looks as though the venture would nevertheless succeed within the next few weeks. At Sollum a big tank battle ended in a draw after we had made the Germans reveal the extent of their strength in that locality. But the weather in North Africa is too torrid at this time of the year for extended operations, so little would have been gained by attempting a full scale battle, and the British withdrawal to its main defences seems to have been the wisest step to take. In America the U.S. Government has none too soon cleared out the German and Italian consulates which were evidential centres of Nazi propaganda, not to say of spying. Finally, the torpedoing of an American cargo liner in mid-Atlantic when on a voyage to South Africa marks a further critical stage in American-German relations and adds yet more emphasis to the probabilities of a definite break before long between these two protagonists of irreconcilable ideologies.

The Toll of the Night Bomber.

The Battle of Britain in the Autumn of 1940 settled for the time being the tactics of the German aerial offensive by daylight on this country. It proved too expensive for Göring's Luftwaffe and by Christmas even desultory day raids on the London area were few and far between; indeed, of late months the even tenor of daylight work in office and factory in Southern England has gone on practically

undisturbed. For this we have to thank the ascendency achieved and maintained by the Fighter Command which can take good care of invaders so long as it can see them in the air. From all accounts its strength nowadays is vastly greater than in those fateful days of August, September and October last, when on some days, we are told, some hundreds of our fighters went up to tackle the invading German squadrons. So it does not seem likely that major daylight attacks on England by the Luftwaffe will feature in the German programme this summer, unless it is part and parcel of a larger invasion tactic.

But it has been another matter with night bombing, which the Germans first tried with effect as far back as last September. All through the winter and early Spring night bombing attacks on London or provincial towns, especially those with harbours, have been a regular feature at short intervals, and damage of one kind or another has been considerable, while the loss of life amongst the civilian casualties has run into several thousands a month, largely because the bomb-dropping has been indiscriminate and has apparently been actuated more by terrorizing tactics than by desire or ability to hit military and industrial targets. In the case of night attacks the Defence has been up against the problem of locating the invading bombers in the dark, a matter of extreme difficulty when it is considered that it is not a matter of location in one plane but in planes at varying heights between, say, 5000 and 25,000 feet. However, our scientists have fortunately evolved methods of detection which judging from recent experience have met with an increasing amount of success, so that even the night raids are now beginning to cost the enemy a percentage in casualties which if it can be further improved will soon exceed the datum line at which the losses become theoretically uneconomic for the invader so far as ordinary raiding is concerned. With the short summer nights and clear skies of the next few months the defence will have the best season of the year in which to perfect its new technique ere the long nights of another winter return. So there is much in the hope that we shall before long have solved the night raider problem, even if never as decisively as was the day raiding one.

But the night raids, as we said above, have taken severe toll of our cities, in particular of central London, as the published accounts of noteworthy buildings that have been either destroyed or badly damaged make only too clear. Within the last few months the City of London has received the attention of the Nazi bombers on several occasions with varying degrees of severity. Mincing Lane, the centre of the sugar, tea and rubber trades, has suffered severely from fire and destruction, in which many of the sugar brokers and the colonial cane sugar merchants have lost their offices. Gone also is the building in which were located the city offices of Messrs. Tate & Lyle Ltd. (and where also, before the amalgamation, both the Tate and the Lyle headquarters were to be found). The Sale Rooms in which the London Sugar Market operated for so many years have also disappeared, but as the functions of that market ceased when sugar was placed under Government Control on the outbreak of war, the immediate loss has been sentimental rather than actual. We gather that at present this market meets on a nominal basis on the floor of a nearby new Rubber Exchange. Other quarters which have not escaped varying degrees of destruction include the corn centre of Mark Lane, some of the numerous shipping offices lying between Fenchurch Street and Leadenhall Street, and, of more distant date, the very old-established book publishing centre radiating around Paternoster Row. Many historical buildings—well known Churches, Halls of City Guilds—have fallen victims to the ruthlessness of the night invader during the past eight months. Yet the City manages to carry on, undismayed; those who have lost their offices have found others nearby (vacated on the outbreak of war by more cautious firms) or else have gone towards the West End of London "for the duration." Whether those that survive and remain have now some grounds for hoping that the worst has been seen is a matter of surmise on which it would be unsafe to dogmatize, but as defence tactics against the night bomber further evolve, the chances of major achievement on the part of the latter should be definitely lessened.

The American Sugar Refining Co.

This year is a milestone in the history of the American Sugar Refining Company, as it marks the completion of fifty years of operations. According to the Company's annual report, the incorporation took place in 1891, and amongst the first five directors were two bearing the well known name of Havemeyer. The company started by acquiring the several properties and assets of the old Sugar Refining Company, and by 1892 had acquired five additional refineries, four of which were in Philadelphia, amongst them being the Franklin refinery. At the start about ten refineries were operated, two in Philadelphia, but from time to time the less efficient plants were eliminated and the more efficient ones expanded. In 1909 a new refinery was built at Chalmette, Louisiana. In 1920 the Jersey City refinery, which had become obsolete, discontinued operations, and a new refinery was built at Baltimore, which began melting in 1922. In 1926-27 the Brooklyn refinery was extensively remodelled. At the present date the company has five large efficient refineries at Boston, Brooklyn, Philadelphia, Baltimore and Chalmette. These are geographically distributed so as to serve the eastern, central, midwestern and southern sections of the United States.

When the company was first incorporated, practically all granulated sugar was packed in barrels and 100-lb. bags only. In 1898 the "American" and other

refineries began experimenting with the packing of sugar in small bags of 5 lbs. weight, though it was thought that the wholesale trade might raise an objection that this procedure would bring the refineries into too close contact with the retailers. However, the experiment seemed to promise success, for the "American" the following year started putting up sugar also in 2-lb. square cartons, 72 going to a packing case. But although this small packaging was tried before 1900, it was not until considerably later that consumers and the trade came to appreciate the innovation. By 1915, however, the company was able to enter on a long-range programme to increase the distribution of sugar in small packages, and to this end modern packaging machinery was installed, intensive advertising and merchandising campaigns were devised, and many additional types of sugar were offered the public in small packets. Thereby was established the standpoint of cleanliness and convenience that resulted from sugar being distributed in small, full-weight, refinery-sealed packages instead of being delivered in bulk to the grocer and by him repacked into paper bags. Today, the company manufactures about 60 types of sugar, in over 300 packings, and advertises its sugar widely under the well-known "Domino" and "Franklin" trade names.

American Refining in 1940.

According to the same Company Report, the European war did not directly affect the domestic sugar market during 1940, but that market was unsettled by conditions existing in the States. The trade felt that the sugar quotas as originally fixed were too high; and they were in fact reduced by the Department of Agriculture in February and again in August. But, as it turned out, these reductions were unnecessary, for the final consumption figure for the year was higher than the Department's initial estimate on which the quotas were based. The market also reflected uncertainties with regard to pending new sugar legislation. There were 77 changes in the price of raw sugar during the year, the high points being in May and December, and the low ones in the summer. In some parts of the country an intensified competitive struggle took place throughout most of the year with many price changes. With beet sugar, competition was unusually keen; the beet industry not only distributed its authorized quota, but in addition delivered in the eastern states in 1940 several million bags of sugar sold in 1939 while quotas were suspended.

Tropical refined sugar pressed upon the market throughout the year in quantities exceeding those of the previous year. A substantial quantity of Cuban refined sugar was released from bond in the last few days of 1939 when the duty was reduced, and was distributed during 1940 in addition to Cuba's 1940 quota. Over 40,000 tons more of Puerto Rican refined was distributed compared with 1939, owing to the quota restriction expiring in February and not being resumed till October.

During 1940 exports of refined sugar from the U.S.A. amounted to approximately 150,000 tons, an increase of about 35 per cent. over 1939 and the largest annual export since 1925. Increased demand from abroad for U.S. refined commenced in the last quarter of 1939, with the beginning of the European war which forced the British refiners to withdraw from their usual export markets. During the first half of 1940 U.S. refined went in substantial quantities to such countries as Norway, France, Switzerland, Finland, Greece, Syria, Newfoundland and Columbia. Cuban refiners and Java producers competed actively with American refiners for this business. But war developments, culminating in the fall of France in June, resulted in the collapse of the export market, and very little sugar was sold for export in the last half of the year. The principal obstacles were the lack of dollar exchange, rigidity of the British navicert control, the almost prohibitive freight and insurance rates, and curtailed consumption abroad due to rationing.

The European war has, indeed, reduced seriously the demand in the world market for raw sugar. The United Kingdom confines its purchases to Empire and colonial sources; France, Belgium and other countries have necessarily bought none or practically none since June, 1940. This has particularly affected Cuba which in recent years used to export about 800,000 long tons annually to Europe. At the present day she has no important market for her raw sugar other than the U.S.A. The price of world raw sugar developed a high of 2·45 cents. per lb. f.o.b. Cuba in the first month of the war, but subsequently declined to a low of about 0·75 cent per lb. by the end of 1940; this last price was in fact only a nominal one, for no market existed. It is less than half of the cost of production in Cuba.

In spite of the difficulties, the American Sugar Refining Co.'s 1940 results were better than those of the two preceding years. But the future outlook, in the view of Mr. J. F. Abbott, the President, hangs a good deal on the nature of the new sugar legislation which needs to be passed this year. The refiners naturally seek for a reduction in the allowable imports of tropical refined sugar and would gladly see curtailed the quotas of the beet sugar producers. Legislation apart, the darkening war clouds, the scarcity of ships and the exercise of Government control have added confusion to the sugar picture. Still, in respect to ships, nearby raw sugar stocks, especially those in Cuba, are ample to take care of the country's cane sugar requirements, even if war developments cut off supplies from distant areas, such as the Philippines.

The Problems of the Sugar Islands.

It is to be presumed that the war will end sooner or later, and it is not too soon, though the primary pre-occupation of those in authority is necessarily with the immediate requirements for securing victory, to consider the problems that will arise when that desirable event is attained. These problems will not be limited to the active participants in the hostilities —the repercussions are world-wide and no country can escape them—and it is hardly less to the interest of the passive participants, among whom a greater freedom for their leisurely study exists, that they should at least be defined. To be fore-warned is to be fore-armed.

The Great War of 1914-18 is not so far distant in time that the morals drawn from it have no present applicability. The social and economic changes of the intervening period have not been too great, though their tempo may have altered. Even before that war the economic inter-dependence of the different countries of the world had proceeded far and a social ferment was permeating all but the most backward communities. To these movements, and especially to the latter, the war imparted an active stimulus which the present war can but aggravate. A grievous error will be committed if the economic problems are viewed in their purely economic aspect and divorced from this social ferment. Such a step will be merely to repeat the errors of the last post-war period without the excuse of inexperience, but it will be a step only too easily taken owing to the conservatism of the average individual.

In no sphere, perhaps, are the social and economic problems more closely interwoven than in the sugar industry, particularly the industries of the tropical sugar-producing islands. In most of these sugar cane occupies a dominant position, the source of wealth to the community of which the prosperity is, therefore, dependert on that industry. In many the concentration on the cane crop has proceeded to an extent which has rendered the population dependent even for its essential food supplies on importation. This is a very vulnerable position and any disturbing influence in the world's markets reacting to the detriment of the price of sugar aims a direct blow at the very foundations of the island's economy.

That the sugar industry is peculiarly liable to such economic upheavals, the last war has sufficiently shown. Sugar has, for long, been the sport of politics. Since the Napoleonic wars, with their disclosure of the dangers to the continental nations of Europe of a dependence on a sugar supply derived from tropical sources, fiscal steps have been taken to build up and maintain a home production from beet. With concentration of man power on military activities, home production fell to a low ebb, and vast new areas were opened up to cultivation of the cane. On the cessation of hostilities, a resuscitation of the beet industry took p'ace in response to the same urge for self-sufficiency arising from the same cause, and the inevitable consequence was over-production accompanied by a cataclysmic fall in price. The same sequence of events characterizes the present war and it would require an optimism exceeding the ordinary to believe that, when it is over, the outlook, the product of generations, will so change that the urge to self-sufficiency will disappear. Nothing less than a general belief that war is a thing of the past can accomplish this. Added to this, a lack of purchasing capacity where foreign exchange is involved, will compel a resuscitation of the beet industry. Unless the unexpected happens, the sugar industry will be faced with a period of depression and it will be wise to take what steps it can to meet the situation. As has been said, owing to the dominance of sugar in the economy of many of them, it is the tropical islands which will feel in fullest measure the economic blizzard.

The problem presents itself in two aspects. On the one hand, the broader aspect, the Government is concerned as trustee for the welfare of the community as a whole; on the other, the narrower aspect, the industry has a natural and justifiable desire to produce sugar at a profit, two interests which are not necessarily in mutual accord and may be opposed. Thus, labour being the major charge in cane production on the plantation, anything tending to reduce the labour bill, provided the standard of cultivation is not materially reduced, is of advantage to the industry. This reduction may be attained in various ways, of which a cut in wages is the most direct. Such a proceeding, with a reduction of the spending power, leads, however, to repercussions throughout the community where the labour force forms a considerable fraction of the population. It may be less direct, by the introduction of mechanism. As is increasingly the case, fixed charges for purchase, and maintenance plus cost of working are found to be less than the cost of labour alone. In such a case a body of labour is cast adrift with small opportunity for alternative employment and becomes a source of concern to the Government. A third method consists in turning over part at least of the cultivated area to small growers and purchasing from them the cane, the system known in the West Indies as cane farming. It is a system which has its advantages; family labour, not being reducible to cost accounting, is cheaper. But it has its disadvantages. The standard of cultivation is lowered, the risk of disease is increased and, ultimately, problems as to what is a fair rate to pay for cane become a bone of contention.

The problems here facing the sugar industry are not easily solved. Labour is no longer the passive instrument it used to be in earlier times. The social aspect, has, in fact, become a practical issue. The cinema and the spread of the press have given a knowledge of the wider life lived elsewhere while the extension of education has raised desires for a higher

standard of living which a period of depression cannot supply. The industry is here faced with a world movement which is beyond its individual capacity to stay and any attempt to stay it results in social upheaval. Such upheavals have occurred in many countries and, not least, in the tropical islands. In the West Indian islands, Mauritius, Zanzibar and, at an earlier date, Fiji, they have assumed proportions which have, in cases, led to Commissions of Enquiry whose findings have from time to time been reviewed in this Journal.[1]

If the changes which were the product of the last war were of a magnitude to cause such social upheavals, it is reasonable to think that those resulting from the present war will be no less intense. A world-wide lack of purchasing power, an increased production and a more restive labour force will co-exist and the result will inevitably be widespread unrest unless steps are taken with that forethought which arises from a clear appreciation of the forces at work. It will be of interest, therefore, to study briefly the methods hitherto adopted to meet the situation and to measure the degree of success which has followed their adoption.

It is obvious that no complete remedy lies within the power of the individual producing unit or even of any individual Government as representing a single island. The basic trouble lies in the maladjustment between world production and consumption. It has been met by international agreement and a system of quotas, a subject which lies beyond the scope of the present discussion.

With the local aspect there are, as has been said, two parties concerned, the producing unit, factory or plantation, whose primary and limited interest it is to reduce the cost of production of a unit of sugar to the minimum, and the Government which is concerned with the wider interests of the community as a whole and only with the narrower interests in so far as the two interests are inter-dependent. Government has to take cognizance of the fact that action which may be of benefit to the more limited interests, may react to the detriment of the community at large.

It is unfortunate, but readily understandable, that the response of the producing unit to depression has universally been an intensive system of cultivation leading to larger returns from the unit area which, under the quota system, involves restriction of the area under cane and the passing of land out of cultivation. Part and parcel of this process is mechanization with its accompaniment, labour, often landless labour, thrown out of work. Alternatively, an extension of cane farming is adopted which, if it does not throw land out of cultivation to the same extent—since the lower standard of cultivation results in lower yields, creates an unsatisfactory atmosphere of rivalry between the peasant farmer, the seller, and the purchasing factory. Both offer problems for Government. To take the latter, and simpler, case first. The successive stages are inevitable; demarcation of factory spheres of influence with the establishment of a monopolistic market for the cane, neglected cultivation leading to centres of disease and, above all, a spirit of rivalry within the industry. It is a rivalry which has sometimes caused Government, as in Trinidad, to intervene by establishing a rate of payment for cane based on the price of sugar and determined by an officially constituted body.

Government has also to deal with the wider problem of land going out of cultivation and of labour out of employment associated with which is that of the dependence of the community in general on an imported food supply. Few of the islands are self-supporting in this matter, as witness Mauritius and various of the West Indian islands. A recent Bulletin[2] has given the facts with regard to Puerto Rico; 35 per cent. of its food supplies is imported including 99 per cent. of its rice, 60 per cent. of its legumes, 51 per cent. of its meat, 34 per cent. of its dairy produce, 18 per cent, of its green vegetables and all its fats. Thus there is ample opportunity for replacement by home production of food stuffs, there is the unemployed labour, largely landless, and there is the land. The problem in its practical shape is to bring these two together.

The solution of this problem has been sought by the Governments concerned in the establishment of settlements of small-holders for which land is, if necessary, acquired. Favourable terms and assistance during the early stages are provided and, to meet the difficulties of marketing of produce, co-operative organizations for sale with provision depots are organized. The West Indian islands offer many examples of the various attempts to find a solution along these lines and a wealth of experience has been acquired of the difficulties encountered. It will probably be accepted as a not unreasonable summation of the results of these experiences—and, in saying this no criticism is intended of the enthusiasm displayed by those entrusted with the experiments—that the success of these schemes is only a qualified one and hardly sufficient to justify the hope that a remedy commensurate with the problem has been found.

In searching for an explanation of this comparative lack of success, one defect presents itself; there is little co-ordination between the activities of the two parties concerned, the plantation and the Government. The superabundant labour is cast off by the former to be absorbed as far as possible by the latter in its settlement schemes. In spite of the care disposed on, and the interest taken in its labour by the management in recent times in such matters as housing, sanitation and medical attendance, the relationship between the plantation and its labour remains fundamentally one of bargaining between

1 *I.S.J.*, 1938, p. 375; 1940, p. 140.

2 *The Food Supply of Puerto Rico*; *Agric. Expt. Stn., Puerto Rico, Bull.* 55, 1940.

rival interests and, where the rivalry becomes too intense, Government intervention takes the form of adjudication. It is even doubtful if, when official intervention takes the form of recommending higher rates of pay for labour, as was suggested by the recent Commission of Enquiry in Mauritius, any real benefit accrues to labour as a whole, for such action can only stimulate the use of labour-saving appliances; the individual labourer may gain but much labour will be thrown out of employment.

Settlement schemes, too, suffer from the disadvantage that there is in them little of that stimulus to effort, especially necessary in somewhat enervating climates, which will carry the individual over the stage when the profits which hard work might bring in, are absorbed in the repayment of the perhaps too readily acquired credit. Many fall by the way-side; they have little to lose if their credit is called in and, meanwhile, a life of leisure is so satisfying. But, beyond this, it is very doubtful if the return from such small-holdings producing perishable goods can ever yield a return much over bare subsistence or sufficient to satisfy the desires which have been awakened; in few countries is the return commensurate with the labour involved.

It is, perhaps, hardly yet sufficiently realized that the plantation and communal aspects of the problem are inter-dependent and incapable of independent solution if a permanent and lasting settlement is to be attained, for attempts to solve the one may only aggravate the other. From the factory point of view a cheap supply of cane is required and, as a general proposition, it may be said that the cheapest supply is given by cane farmers; for labour, taking the form of family labour, ceases to be a direct charge. Cane farming, however, has its disadvantages in a lower standard of cultivation leading to reduced yields per acre, in danger from disease and in difficulties in arranging for regular supplies of mature cane. These are grave disadvantages, but disadvantages which can be overcome by the employment of a technically qualified supervisory staff. But the main compensating advantage is the replacement of a clash of interests between management and labour by a community of interests. Under a scheme based on these lines, by a judicious planning of holdings, the heavier items of the cultivation programme can, if economically desirable, be conducted by mechanism provided by the plantation and the lighter operations conducted by family labour. By a judicious use of mechanism much of the labour lost to the plantation under a full system of mechanization will be retained, while technical supervision will lead to higher yields and reduction in the risk from disease.

In practice, where the land is owned by the plantation, the system involves the subdivision of a portion of the plantation lands into family holdings of a size that such a moiety of each is under cane as can be well cultivated by a family unit under technical guidance and the grouping of these holdings into larger units for the purpose of such operations as co-operative harvesting. That the scheme is no visionary idealism of the arm-chair enthusiast is shown by the fact that it is already in practice in more than one area, and on a very large scale. In one area, at least, it has arisen as a switch-over from the more usual plantation practice of employment of a paid labour force. Further details have already appeared in this Journal.[1]

Where the land is not mainly held by the plantation but is peasant freehold, the owners of which enter into contract for the supply of cane with the factory, the problem does not offer the same ready solution. Peasants are peculiarly tenacious of their freehold rights and any attempt to restrict these is always strongly resented. Here a solution might be found in the exploration of the possibilities of intervention by Government along the lines of restriping, schemes for which have proved their worth in countries such as India where the question of the uneconomic holding forms so serious a problem.

If the difficulties in these latter cases are great, the argument does not apply to the settlement schemes which are under development for the relief of the unemployed labour problem. Here there is a free hand. Selection of sites within reasonable distance of a sugar factory, subdivision into holdings forming family units taking into consideration that a defined part of each shall be under cane and the remainder of a size to provide sustenance for the family, alignment of these so that the heavier operations may be mechanically performed and introduction into the lease of terms placing at least the portion under cane under the technical supervision of the factory authorities, constitute the major items of the programme. A practical example, taken from the Sudan, may help to explain the working of the scheme. Here the land is divided into 30-acre blocks, the family holding, of which one third is—or was, as recently a four-year has been substituted for a three-year rotation and the details are not to hand—annually under cotton with the Corporation undertaking the heavier operations and having a lien on the produce; one third is left fallow and the remaining third at the disposal of the tenant.

Can it be doubted that a tenant, having as he would have a sure cash income in addition to much of his sustenance requirements, will not be better off and, therefore, more contented than one dependent on a somewhat precarious return for perishable produce while subject to a large measure of official control? Co-operative action along these lines provides the most promising solution of the problems facing the sugar industry and Government acting as agent for the community

H. M. L.

[1] *I.S.J.*, 1933, p. 103.

A History of Sugar Cane Varieties in Mauritius.

With the intensive breeding of sugar cane varieties which is proceeding in practically all the cane growing countries of the world, and with the supersession of older varieties, to the extent of practical eliminisation, — it is already stated to be impossible to find some of the standard canes formerly grown in Northern India—there is more than a possibility of a loss of all record of the varieties formerly grown and, if this hiatus in the history of these countries is not to become permanent, it is not too soon to collect all available information on the subject. A welcome attempt in this direction has recently been made for Mauritius by G. C. STEVENSON.[1] Apart from the purely academic interest of such a record in a country the prosperity of which is, and has been, so intimately bound up with sugar, it has a practical interest in that these older varieties not infrequently enter into the biological make-up of the newer ones which have succeeded them.

It is a commonplace statement to say that success in plant-breeding is largely dependent on, if not proportional to the knowledge of the parental material. It is, therefore, of the utmost importance to identify as far as possible the original stocks. Unfortunately full identification is not possible for, in spite of the permanent collections which have been established in Java and Puerto Rico under the stimulus of the International Society of Sugar Cane Technologists, some have been irretrievably lost. To a greater extent, perhaps, than any other plant has the sugar cane been carried round and round the globe and, in the process, new names, associated with the country of origin, the name of the importer or some peculiarity in the cane itself, have been applied in its new home. The consequent confusion is one which these collections have done much to clear up.

Sugar cane cultivation in any particular area can usually be divided into fairly clear-cut phases each characterized by a limited number of varieties. In the earlier stages the change was usually forced, the impetus being provided by disease. The life of a variety was relatively long when compared with modern experience, a fact probably due to the conservatism of the planting community, though it must be admitted that the solution offered to explain the shorter life of the newer varieties appears too simple. This evolution of newer varieties, so characteristic of the last 25 years or so, with the result that variety succeeds variety in rapid succession, is held to be a response to a growing demand for varieties adapted to narrow ranges of environment. There is, of course, much truth in this ; but it is equally arguable that, except where resistance to disease is specifically aimed at, the tendency in breeding is to concentrate on the characters of major economic importance to the neglect of those more subtle characters rather vaguely summed up by the term stamina. There is something more than a suspicion, though possibly falling short of definite proof, that many of the products of the plant breeder are deficient in those characters.

Sugar cane was first introduced into Mauritius in 1650 when the island was in Dutch occupation as a convict settlement with ebony the main product. Mauritius missed, therefore, the first migration of cane in the fifteenth century through the agency of the Arabs to the Levant and Spain, of the Portuguese to Madeira, Canaries, Azores and West Africa and of Columbus to the New World. The Creole variety which was concerned in this movement, a variety recently identified with Puri of India, Geel Egyptish riet (Yellow Egyptian cane) of Java and Cana Criolla of Latin America, does not appear to have been cultivated in Mauritius, the Canne Creole of the island having no association with true Creole. It is doubtful if the canes of this introduction survived the departure of the Dutch. The first cane to be really established was brought by the French in 1715 from Madagascar via Reunion and was probably the Otaheite cane, a variety which was of South Pacific origin and became the standard cane for an extensive period in a large number of the cane growing countries. The Otaheite cane was undoubtedly introduced by Bourgainville between 1766 and 1768 and there is nothing to show that this differed from the cane already grown. It formed the backbone of the sugar industry till about 1840 when it succumbed to epidemic disease.

Otaheite was succeeded by Cheribon canes, striped, light and black. The introduction of these is traced with some assurance to Cossigny in 1782 though there is certain evidence that Guinghan (Striped Cheribon) had been known long before that time. The period between 1840 and 1858 was one of transition but, by the later date, the sugar industry was again firmly established on the basis of the Cheribon canes. Between that date and 1879 Mauritius received a large number of varieties from many countries through, chiefly, the agency of MELLER, CALDWELL and HORNE and the island became possessed of a more representative collection of varieties than any other country. Many of these later-received varieties were of the Cheribon series under a varying nomenclature. From Java Rappoe, from New Caledonia Naga, from Fiji Namuri constituted the light form ; from Java Meera, from Queensland Java Black, from New Orleans Louisiana Striped, from Java Striped Cheribon constituted the striped form. With this advanced experience and this wide collection of canes, Mauritius became the centre of distribution when in country after

[1] *Empire J. Expt. Agric.*, 8, (1940) p. 301.

country—Brazil in 1860, Puerto Rico in 1872 and the West Indies in 1890—disease in epidemic form appeared in Otaheite.

Canes of the Cheribon series are among the most valuable of the Noble canes for breeding purposes and Cheribon blood persists in many of the most valuable commercial varieties of the present time. Thus, among the most recent canes securing popular esteem in the island are M 171/30 derived from Guinghan (Striped Cheribon) through P 131 and M 27/16 ; M 72/31 derived from Black Cheribon on the one side through Kassoer, POJ 2364 and POJ 2878 and from White Transparent (Light Cheribon) on the other through DK 74 and M 35/17 ; and M 134/32 from Black Cheribon on one side through Kassoer, POJ 2364 and POJ 2878, on the other from Light Cheribon through D 109.

A further series of cane varieties which have received much popularity at a later date is the Tanna series, like Cheribon, composed of light, striped and dark forms. The Striped Tanna variety was introduced from Tanna Island in 1869 under the name of Wopandon. From this White Tanna arose as a sport at Pampelmousses in 1892. Black Tanna arose similarly and a series of intermediate forms have also arisen. Elsewhere similar sporting has occurred giving rise to Yellow Caledonia of Hawaii and Malabar of Fiji, both corresponding to White Tanna The appearance of the Tanna canes in commercial cultivation took place at the end of last, or early in this century It became the most popular cane, attaining 63 per cent of the planted area in 1925, a figure which had dropped to 38 per cent in 1938. Its peculiar advantages are resistance to gumming disease and adaptation to the colder and higher rainfall districts. Owing to the complete sterility of the anthers, Tanna canes have not proved of utility in breeding in Mauritius though crosses have been obtained in Hawaii where, crossed with H 109 (of Otaheite lineage), they have given rise to 31-1389, a variety which has become the standard cane of certain tracts.

A further cane which came into popularity on the failure of Otaheite is the Penang or Selangore variety. This may have been introduced in 1843 but was certainly among those introduced in 1850. But its main interest lies in the use made of it by Perromat as a parent. 33 P, 55 P and 87 P arose in this way while 55 P is the parent of several of the later varieties now cultivated and its derivatives are still included in the breeding programme.

In recent years attention has been directed to nobilized and inter-specific hybrid canes, thus following the developments in other cane growing countries. The stimulus to the employment of these arose in Java where Kassoer was found to be immune to Sereh. Kassoer being proved later to be a natural hybrid of Black Cheribon and *S. spontaneum*, the Javan offspring, among them POJ 2878, were nobilizations of the second or higher orders, and it was Barber in India who first went to the root of the matter by crossing noble varieties with the wild *S. spontaneum*, thus producing nobilizations of the first order. A large percentage of the newer varieties now grown throughout the world are examples of nobilization of a higher or lower order.[1]

Disease has been, as has been said, the compelling factor in this development which is not without certain disadvantages. There is often a tendency to a short vegetative growth cycle which is a small disadvantage and may be a gain in countries like Northern India with its short season of some nine months. Where conditions are favourable for varieties with a long growth cycle, such as Barbados and the *grande saison* districts of Mauritius, the disadvantage is considerable and it would seem that varieties of pure noble origin are still the best, for if adequate resistance to mosaic is not obtainable for districts where this disease is prevalent, adequate resistance to gumming is obtainable among canes of purely noble origin, the variability of which has not, it is held, been fully explored. Though nobilization is not being discarded in Mauritius, the main effort is, for this reason, being devoted to the breeding of noble canes.

The nature of the problem which confronts the cane breeder of the present day is changing. The big advances which have characterized the early stages of breeding along modern lines in sugar cane as in other crops, are not likely to be repeated and the process is one more example of diminishing returns. The whole movement is in the direction of increased number of varieties in any particular sugar cane country, each adapted to the local conditions. But that is not the end of the matter. The history of the sugar cane is rich in examples of a flourishing industry brought to the verge of ruin through the sudden outbreak of disease in epidemic form. This history may easily repeat itself. With the transportation of cane varieties from one country to others, the risk of introducing disease into areas where it is now unknown must exist in spite of the quarantine measures adopted. It is coming into recognition, too, that pathogens may change their nature and that one which is now of little or no economic importance, may become a serious danger through increased virulence. These are possibilities which the plant breeder of the present day must be prepared to face ; they require from him a closer study than formerly of varietal adaptation to environmental conditions and an ability to produce resistant varieties of good quality at short notice. The material is there but his work is, of necessity, largely empirical, for the cane plant is, genetically, very complex and the characters of economic importance are quantitative. His great asset is that, having got the desired combination, it is unnecessary to fix the characters.

H. M. L.

[1] See *I.S.J.*, 1935, p. 341.

The Mobrey Juice Level Control

For Evaporators.[1]

By H. G. McKENNA.

It has long been recognized that the efficiency of an evaporator is largely governed by the juice level, and that if the personal control of the attendant cou'd be replaced by a mechanically self-operating device greater capacity and steam economy would follow.

Towards the end of last season the Mobrey juice level control apparatus was installed in the pre-evaporator at Doornkop, Natal. It had already proved useful in several beet factories in England, but this was its first appearance in Natal.

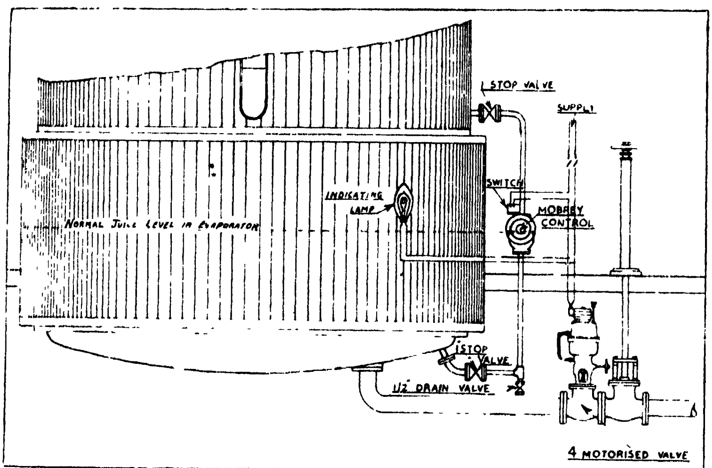
Several points have to be improved upon, and it is hoped that a further study of the apparatus will better its performance this coming season.

The Mobrey control is a float-operated device activated by changes in the level contained in a float chamber. It consists of two separate parts : (1) the float mechanism, and (2) the motorized valve.

The float mechanism is connected directly to the pre-evaporator through 1 in. bore pipes to the juice gauge cocks. It consists of a float enclosed in a chamber, the float being connected to the actuating arm of an electrical switch by means of a transverse spindle passing through a special gland in the chamber.

The motorized valve is placed in the juice supply line on the delivery side of the juice pump. This valve consists of a small motor mounted on top of an oil chamber. In this chamber is a gear type pump which exerts pressure on the piston which closes a spring-loaded valve, thus throttling down the flow of juice.

The float mechanism is placed at the same height as the desired juice level, that is, half way up the tube height in the evaporator. This means that during boiling the top tube-plate will just be covered. The switch already referred to is connected to the motor on the motorized valve.



General arrangement of Mobrey Control applied to a pre-evaporator to operate motorized valve fitted in juice inlet.

Unfortunately, the trial was hampered by an erratic cane supply, but sufficient experience was obtained to see that it will prove a great help in the control of the evaporator.

The Doornkop evaporator consists of a 3,000 sq. ft. pre-evaporator coupled to a 4,500 sq. ft. triple effect, the vapour from the pre-evaporator being utilized in juice heating and in the first pot of the triple.

Under certain conditions it was found almost impossible to maintain a satisfactory juice level in the pre-evaporator, and many ideas were tried out to overcome this difficulty. Best of all was an overflow pipe back to the evaporator juice supply tank, an idea that could be taken up by many factories with considerable advantage.

To improve upon this, and perhaps to work in conjunction with this overflow pipe, the Mobrey control was installed. Even with our short experience of it, we believe it to be capable of doing useful work.

In operation, the float rises or falls with the juice level in the pre-evaporator. When the level rises the float, acting on the transverse spindle, closes the switch, which starts the motor operating the oil pump in the motorized valve.

The oil pressure thus developed acts on the face of the piston and closes the spring-loaded valve, thus shutting off the supply of juice to the evaporator. So long as the juice level remains higher than the pre-determined height set for the float, the switch will remain closed and the motor will continue to act on the oil pump closing the juice supply through the valve. A relief valve, allowing for about 10 lbs. greater oil pressure than is required to keep the juice valve closed, is provided.

When the juice level falls, the float allows the switch to open, releasing the oil pressure against the piston. The juice valve then opens to allow a flow of juice to the evaporator.

[1] *Proceedings of the* 15*th Congress of the South African Sugar Technologists' Association.*

This may sound somewhat complicated, but, once the apparatus is actually fitted up, it functions very simply. The juice level is controlled within a few inches of the pre-determined height, which, to say the least, is something that the usual evaporator attendant cannot maintain.

Like the majority of mechanical devices, the application to local conditions has to be studied. For instance, the juice pump (centrifugal type) was of greater capacity than was needed to handle our volume of juice, so that the supply was in consequence more intermittent than it would otherwise have been with a smaller pump. The motorized valve was therefore in operation, that is, the juice valve was closed, longer than we believe it should have been.

Again, for the proper functioning of the motorized valve, we had to experiment with several oils to maintain the pressure. The oil specified by the makers is a high grade turbine oil such as Shell BA8.

As an addition to the outfit, we thought it advisable to install an indicating lamp in the circuit, so that when the motorized valve started to operate the lamp was lit. This was necessary in our case as the motorized valve was not visible to the attendant on the evaporator floor.

We believe that the Mobrey control has definite possibilities. Its installation between each vessel in a multiple effect would be a great advantage. With a steam control device, a final syrup density control and the intermediate control as indicated, our evaporators would be entirely automatic, or would require only a casual inspection.

A Typical Scene in Bombed London

The Sugar Quarter in Mincing Lane.

The Soda-Lime Process for Feed Water Treatment.

Possible Application to Juice Clarification.[1]

By N. SMITH.[2]

It would appear that the average sugar technologist is not well versed in the practice of water treatment, it being only in the last two or three years that serious consideration has been given to the problem in our industry. Many engineers would like to install some cheap and simple treatment plant, but have hesitated on account of the lack of precise data. It is therefore felt that the results of laboratory investigations and of factory experience gained at the Sarina Distillery, Queensland, may be of interest to the industry.

However, there is another object in the presentation of this paper, viz., to point out a similarity between the processes of water softening and juice clarification. But whereas the reactions involved in water softening are comparatively simple and straightforward, the chemical and physical reactions of juice clarification are so complex that very little is really known of this important process. It is therefore felt that the following remarks on the removal of impurities from water may suggest fields for investigation with regard to the elimination of the wide range of impurities from the juice.

Principle of Lime-Soda Process.—Lime (calcium hydroxide) is added to the raw water to precipitate the bicarbonates of lime and magnesia (temporary hardness), while soda ash is added to precipitate the sulphates, chlorides and nitrates of lime and magnesia (permanent hardness), after which the precipitated matter is separated by settling, usually supplemented by filtration, giving a clear water containing only a small residuum of scale-forming salts in solution. Generally the process is carried out continuously.

Magnesia is difficult to remove, as it is precipitated in the form of colloidal magnesium hydroxide. Hence comparatively small quantities of sodium aluminate are now generally added to provide colloidal particles of opposite electrical charge, and so produce flocculation of the magnesia, resulting in more rapid and more nearly complete separation. The lime-soda process is therefore very similar to juice clarification, and well adapted to control by sugar chemists.

Laboratory Investigations.

A 10-gallon sample of creek water was taken for investigation. It showed the following anaysis: Temporary hardness, 12·5 (expressed as equivalent parts of $CaCO_3$ per 100,000 parts of water); permanent hardness, 1·6; and total hardness, 14·1; hardness due to lime, 7·8; ditto to magnesia, 6·3. The calculated (stoichiometric) quantities of reagent required to remove the whole of the hardness are: hydrated lime, 1·39 lb.; soda, 0·17 lb. per 1000 gall. of water. Various experiments on the speed and completeness of the reactions at different temperatures were carried out.

Effect of Temperature.—At a temperature of 60°C., it was seen that the bulk of the reaction was almost instantaneous, but it was not complete, even at the end of five hours. At 40°C. the reaction was similar in type, but neither so rapid nor so extensive; while at 20°C. it was yet slower and even more incomplete.

Effect of Excess of Reagents.—Adding the calculated quantities of lime and soda at 60°C., the hardness was reduced from 14·1 to 6·0 in half-an hour and to 4·9 in five hours, but such a result is not satisfactory from the point of view of percentage removal of scale-forming salts. On addition of a small excess of the reagents, viz., 0·15 lb. lime and 0·1 lb. soda, per 1000 gall., the hardness was reduced to 3·8 at the end of five hours.

This would represent a fairly satisfactory feedwater for low pressure boilers, even without dilution by condensed steam return. On, however, doubling the excess of lime and soda, the hardness was reduced to 2·2, an excellent result. Trebling the excess of reagents gave only a slight further improvement, and this was at the expense of increased alkalinity with consequent increased danger of carry-over of water in the boilers, and of caustic embrittlement.

Next the effects of adding sodium aluminate was studied. In some of the tests, various amounts of aluminate were added to the waters at 21°C. in addition to half the optimum excess of lime and soda. In the case of no addition, the initial reaction was comparatively slow, and it was only after five hours that a reasonable reduction in hardness was obtained. Addition of only 0·062 lb. (1 oz.) of aluminate per 1000 gall. of water showed a very marked improvement, the bulk of the reaction occurring almost instantaneously; doubling the addition showed a further marked improvement. Quadrupling the dose gave a yet further improvement, but by no means in proportion to the increase in aluminate. Hence, the addition of 0·125 lb. per 1000 gall. is probably about the optimum.

Factory Experience.

Plant.—The boiler feed water at Sarina amounted to 1200 gall. per hour, the rate being almost uniform. It consisted wholly of raw creek water with a total hardness of 15 to 16 parts per 100,000, half of which

[1] *Proc. Queensland Soc. Sugar Cane Tech.*, 12th *Conf.*, pp. 7-24 (here abridged).
[2] Australian National Power Alcohol Pty. Co., Ltd., Sarina, Queensland.

was due to magnesia. It produced very heavy scaling of the boiler tubes, feed distribution tubes, and even boiler drums. De-scaling had to be done every two or three months, when the effective diam. of some of the 4 in. tubes and feed pipes had been reduced to ½ in. Carry-over of water in the steam was very bad.

It was decided to build a temporary water treatment plant from available material; as we had had no experience in the design of such plant, the keynote was cheapness and simplicity. As seen in Fig. 1, it

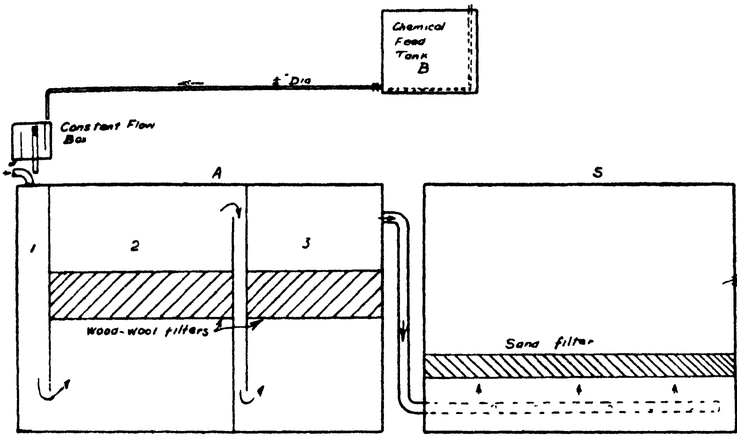


Fig. 1.

consisted of a reaction-settling tank A with two wood-wool filters. Charges of lime and soda were mixed together by compressed air in 400 gall. of water. A charge was mixed every six hours, and pumped to chemical feed tank B agitated by compressed air, from which the chemicals gravitated through a ½ in. pipe and a constant flow box C to the treatment tank A. The surplus flow from the constant flow box gravitated to a tank, from which when the return amounted to 400 gall. it was pumped back to the chemical feed tank.

Initial results were very poor. In short the chemicals added precipitated about two-thirds of the scale-forming salts, and practically the whole of these entered the boilers with the feed. However, even this crude treatment showed a considerable improvement as regards scaling of the boilers, though the carry-over of water into the steam was still very bad.

Hot condenser water at 40°C. was next treated, which produced a more flocculent precipitate, most of which settled out in compartment 2 of settling tank A; of that portion of the precipitate which did not settle the wood-wool filters retained the coarser flocs, but very fine particles passed through, resulting in slightly turbid water. A sand filter was then installed to remove this fine suspension, but both the wood-wool and the sand filters choked rapidly.

Aluminate treatment.—Addition of sodium aluminate at the rate of 2 oz. per 1000 gall. of water was made to the chemical feed tank with the lime and soda, which was added to the raw water heated to 60°C. Excellent flocculation and reduction in hardness were obtained, but a large percentage of the precipitate floated to the top compartment 2 of the settling tank. Lowering the temperature of the water to 40°C., reduced the scum to a small extent. Increased doses of aluminate aggravated its formation, and finally the dosage of aluminate was reduced to 1 oz. per 1000 gall. with an appreciable improvement.

This addition of aluminate resulted in the reduction of the residual hardness from 3·1 to 2·8, the flocculation being improved, even at 60°C. Moreover, the claim that aluminate assisted in the removal of silica was substantiated; with and without aluminate, the SiO_2 is now 3 and 5 mgrms. per litre respectively, the raw water originally containing 10 mgrms. per litre.

Sludge Filtration.—Originally the practice was to run out the heavier portion of the sludge from compartment 2 of the settling tank once per day. Eventually it was noted that for the next few hours after the sludge withdrawal the feed-water would run fairly turbid; then gradually the water would clear again until after the next sludge withdrawal. It thus appeared that the sludge filtration which was taking place was very effective, and a deeper bed of sludge was maintained. After this it was found that water passing from compartment 2 to compartment 3 of the settling tank was so efficiently filtered as to be entirely free from even the smallest particles of suspended matter.

Practically no sludge formed in compartment 3, so that in effect the treatment plant now consists of compartments 1 and 2 of the settling tank only, compartment 3 and the sand filter tank S merely acting as reserve supply tanks. The much greater density and coarseness of the sludge suggest that during filtration through the sludge bed the sludge particles act as nuclei for further precipitation of impurities. This is supported by the fact that by utilizing a deeper bed of sludge the residual hardness of the feed-water was reduced from 3·3 to 3·1. In addition, this utilization of sludge filtration almost completely eliminated the formation of floating scum in compartment 2.

The Spaulding Precipitator.—In water softening much attention is now being given to sludge filtration. In a recent article,[1] APPLEBAUM gives drawings of

[1] *Ind. & Eng. Chem.*, 1940, **32**, p. 678.

several new settling or sludge-filtration tanks of the Spaulding type for use in conditioning municipal water supplies. Then there is the well known Kennicott settling tank, where the water flows down a large central pipe, then upwards inside the cylindrical tank, an average vertical velocity of 6 ft. per hour being allowed apparently with satisfactory results. In the case of our own settling tank, the vertical velocity would be 4·6 ft. per hour, so that it represents a very poor design. A velocity of not more than 10 ft. per hour should be allowed.

Results finally obtained.—As a result of the progress made in the various directions discussed, the quality of the boiler feed-water may now be regarded as satisfactory. It is entirely free from suspended matter, and there is very little carry-over water with the steam. On opening up the boilers after 11 months of continuous operation, they were found to be almost entirely free from scale. Average analyses of the raw and treated waters in parts per 100,000 as $CaCO_3$ were as follows:—

	Raw.		Treated.
Temporary Hardness	12·0	..	—
Permanent Hardness	2·1	..	—
Hardness due to Lime	6·8	..	1·0
Hardness due to Magnesia..	7·3	..	1·8
Total alkalinity	12·0	..	4·5
Silica, mgrms. per litre	10·0	..	3·0

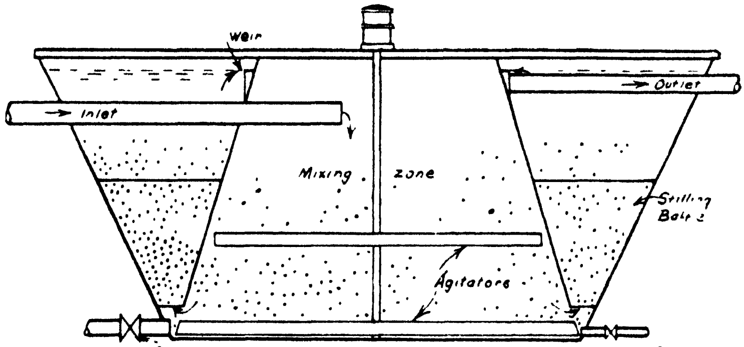


Fig 2.

Possible Application to Juice Clarification.

As already indicated, there is marked similarity between the processes of water treatment and juice clarification. In both cases chemicals are added to precipitate the maximum amount of impurities; in both instances colloidal matter is present, and has to be either flocculated or adsorbed by precipitated matter, after which the precipitate, which is very similar in physical properties, has to be separated rom the liqu d.

However, of the two processes, water treatment is by far the simpler and high standards of efficiency in operating it have been attained. In our own case, 80 per cent. removal of impurities was effected, compared with only about 17 per cent. in the case of juice clarification. An attempt may therefore be made to apply our experiences with water treatment to the complex problem of efficient juice clarification.

In the first place, there is the fact that ultimate success in water treatment calls for exact methods of measuring the efficiency of the process. What is needed is some method of analysing the juice, whereby the ultimate efficiency of clarification can be predicted. Purity rise may be the most convenient available, but is far from satisfactory. The range of variation in the purity of juices is of the same order as the purity rise, so that sampling and analytical errors may vitiate the significance of the purity rise. Furthermore, the most objectionable impurities in cane juice are perhaps the very small amounts of colloidal substances, such as gums and waxes, and any improvement in the elimination of these would probably not be revealed in the purity rise, even assuming perfect sampling and analysis.

Reactions involved in water treatment do not approach equilibrium until the lapse of a considerable time. In Queensland in general the juice is limed, heated, and passed to the subsiders, all in a matter of a few minutes, the precipitate being then separated as rapidly as possible. In other words, the times of reaction and contact between the precipitate and the juice are each a minimum; one wonders whether they might not be prolonged with advantage. It is quite possible that the advantages of double liming are due in part to the provision of such a reaction tank. A laboratory investigation into the effect of prolonged reaction time would seem to be warranted.

Our experience with water softening has shown very strikingly the efficiency of sludge filtration for complete removal of suspended matter. Whereas pure settling alone resulted in turbid water, sludge filtration yielded a perfectly clear effluent. Furthermore the longer contact time between precipitate and water apparently results in more precipitation of impurities. Again, sludge filtration does not require such bulky equipment as in the case of pure settling, followed by filtration.

Clarified juice generally shows a marked turbidity in Queensland, and it is felt that sludge filtration would remove much of it, as in the case of water softening. In the Seip Clarifier sludge filtration is definitely aimed at, but here the depth of the bed is apparently only a few inches, whereas in water softening a depth of several feet is found most desirable. Moreover, in sludge filtration a vital need is some provision for varying the depth of the bed so as to establish the optimum depth for any set of operating conditions.

Probably the Spaulding Precipitator (Fig. 2) will prove of considerable interest to Queensland technologists, as this design could readily be incorporated in existing conical subsiders. It would seem worth while to carry out laboratory scale tests with a view to testing the efficiency of this particular design. In any case an investigation of sludge filtration would seem to be justified.

The Sweetness of Sugars and "Gurs."[1]

By D. G. WALAWALKAR, Imperial Institute of Sugar Technology, Cawnpore, U.P.

It is generally believed in India that khandsari sugar and gur are much sweeter in taste than white crystal sugars, although the former contain comparatively much less sucrose. Similarly on the continent of Europe, the colonial sugars sold for domestic purposes are regarded as much sweeter than white refined sugars. Cane sugar was once believed to be 25 per cent. sweeter than beet sugar.

In Java the local palm (*Arenga saccharifera*) sugars are said to be exceedingly fragrant and savoury. In India the various palm gurs are supposed to be inferior and unpleasant in comparison with cane gur, except in Bengal where they are considered much superior to it. There are, moreover, certain cane gurs which are bitter and salty.

Unrefined white sugars are regarded as somewhat sweeter than the pure refined; but low grade plantation sugars appear to be less sweet. It is thus seen that the popular belief in the sweetness of sugars of various grades does not appear to correlate with the percentage of sucrose and other sugars present. It is, therefore, necessary to investigate all the factors that affect the sweet taste of sugars, whether pure or impure, so as to ascertain the cause of these apparently erroneous beliefs.

The Sensation of Taste.

Taste is defined as the sensation experienced by the special nerve centres at the end of the tongue. These nerve centres are sometimes called taste-buds or bulbs, and are situated on the surface of the tongue and the soft palate. They consist of numerous structures or *papillae*, which are the termini of the gustatory nerve fibres.

When they come into contact with a sapid substance, vibrations or impulses are set into motion, and are conveyed to the taste centre of the brain. These impulses are created by the sensory particles and their components and the liquid or solution in contact. Gustatory sensations are defined as sweet, acid, salt and bitter.

It is thus explained that the taste sensation is a complex heterogeneous system which comprises the colloidal protoplasmic taste cells or nerve terminations and the liquid solution. The main changes which occur depend upon alteration of surface and electrical energy; equally marked sensations of taste must, therefore, correspond with adsorption of equal amounts of the substance by the organs of the taste.

Experimental investigation confirms the deduction that the sensation of taste is more persistent with increasing concentrations of tasted substances, increasing the adsorption exponent. The particular nerve endings which produce the sensation of sweet taste are incapable of exciting any other taste sensation; but the intensity of this particular gustatory sensation can be modified by another set of nerves in the vicinity being excited at the same time.

The usual sweet taste of sugars can be modified by caramel, flavours, acids, salts, bitter and unpleasant ingredients and their mixtures. Caramel and flavours are not incompatible with sweet sensation, but in the case of others, if the quantity present is beyond a certain limit, it is capable of destroying the sweet taste altogether. An asclepiadae (*Gymnena sylvestre*) known as 'gurmar' is capable of destroying the sweet and bitter taste sensations altogether for some time.

Factors Affecting Taste.

Although the polariscope is one of the best and most exact aids to ascertain the chemical composition of sugars, what it gives is only the polarizing strength of the sugar and not its sweetening power. A great controversy was at one time raised in the United States of America, where the polarizing power of sugar was assumed to be its total sweetness.

This was apparently wrong and was proved so when cane and beet sugars of equal polarization were found to differ in their relative sweetness. The consumer is interested only in the sweet taste, the determination of which is more objective and more difficult to check. The sensation of taste in general, and sweet taste in particular, is influenced by a number of factors which are enumerated below:—

Concentration of solution; amount of solution applied; extent of the taste surface excited; duration of the application; temperature of solution; nature of the preceding and after tastes; fatigue; smell or flavour; touch or feel; sight or appearance.

It is thus clear that the factors governing taste sensation must be rigidly observed when any comparison is made. It is the opinion generally held by

[1] Abridged from an article published in *Indian Sugar*, Feb., 1941.

the lay public, as well as by the pathologist, that the various grades of sugars sold in the market do actually differ in their sweetness, in spite of the fact that their sucrose contents are practically the same. Correct judgment can, therefore, hardly be passed from tasting the crystals because their size and hardness can so considerably influence sweetness.

Methods of Tasting.

Systematic methods have been developed for testing the relative sweetness of sugars. The usual procedure is to determine the lowest concentration detectably sweet which is reached by gradually diluting the solution. The usual concentrations employed are in the neighbourhood of 2 per cent. and such a limit is known under the name of the "threshold" test.

Another method is to determine the "Degree of Sweetness" (DS) of a substance, as the number of grms. of pure sucrose which in a given volume of water has the same sweetening effect as 1 grm. of the substance under comparison dissolved in the same volume of water. No common procedure has been adopted, but the dilution is the usual test carried out and the data are preferably reported compared to sucrose as 100.

Properties of Pure Sucrose.

Pure sucrose obtained from any source must be identical in taste, crystallization, specific rotation, colour and weight. There can be no difference either in sweetening power or preserving quality of such a highly refined product, whether derived originally from cane or beet. That such is the case has been amply proved time and again. But the same is not the case with sugars of either origin when impurities even to the slightest extent are present. Direct consumption cane sugars generally contain reducing sugars, and other impurities present give them an acid reaction ; direct consumption beet sugars do not contain reducing sugars and the impurities present give them an alkaline reaction.

A controversy arose on the relative sweetness of pure cane and beet sugars in the early days of the latter, the so-called "betose" being supposed to have only 70 per cent. of the sweetness possessed by cane sugar or sucrose. Thus low grade consumption sugars contain only a slightly less amount of sucrose, but along with it impurities, namely, reducing sugars, ash and organic non-sugars, which determine the character of the taste.

	Sucrose	Levulose	Dextrose	Invert Sugar
T. Paul	100	103	52	78
A. Bariester and co-workers	100	173·3	73	127·4
J. W. Sale and Skinner	100	150	50	85
Deerr	100	120	60	95
Spengler and Traegel	100	108	—	—
Dahle	100	164	—	120
Washburn	100	164	—	120

In the accompanying statement are tabulated the degrees of sweetness assigned to certain sugars in comparison with sucrose. Many other investigators have assigned similar values but no conclusive proof is forthcoming as to the wide difference between 103 and 173·3 assigned to 'evulose.

Increasing Sweetness by Inversion.

J. J. Williams suggested the use of the superior power of invert sugar as compared with sucrose as a means of increasing the lasting of supplies during the previous great war. He maintained that 100 lbs. sucrose would give 105·24 lbs. invert sugar which, he assumed, has the same sweetening power as 135 lbs., on the basis of levulose being much sweeter than sucrose.

But according to Noël Deerr the sweetness of the invert sugar solution does not appear to agree with the mean of that found for dextrose and levulose. No doubt the possibility of increasing the sweetening power of a given weight of ordinary sugar by the simple process of inversion appears to be an attractive proposition. In the beverage and ice-cream trade this property of increasing the sweetness by use of invert sugar led to the belief of saving expense—a saving of 22 per cent. on sugars was expected by Fraudsen.[1]

But Sale and Skinner concluded that 342 grms. of sucrose yielded 180 grms. of each dextrose and levulose and since the DS of invert sugar to sucrose is 85 : 100 they averred that the result of inversion contrary to belief was a nett loss of about 11 per cent. on the sweetening power. Others advocate that a nett increase of 30 per cent. in sweetening is to be gained by inversion.

Such an increase could be easily detected by the normal sense of taste, but this increased sweetness is not borne out by facts and the so-called increased sweetness does not appear to be due to invert sugar or levulose but appears to depend upon other factors which are associated with the invert sugar. The taste of invert sugar prepared by different inversion media differs a great deal, that of acid inversion appearing to be sweeter.

Substances affecting Sweetness.

Substances which undoubtedly increase the sensation of sweet taste are always present in direct consumption cane sugars of the Demerara type and to a less extent in plantation white sugars. In such sugars there is present just the trace of acidity capable of intensifying the sweetness. Moreover, such sugars possess the delicious aroma of the cane juice which distinctly enhances the sensation of sweetness.

Demerara Yellow sugar may contain 1·5 to 2·0 per cent. reducing sugars and they are regarded as somewhat sweeter, weight for weight, than refined sugars, but after all, the probable difference may not amount

[1] *I.S.J.*, 1940, p. 428.

to a very great one. The same sugar when washed free of the syrupy film and re-crystallized from solution appears to lose the increased sweetness.

Palm sugars or raw sugars when decolorized by the use of bonechar or activated carbon appear to be less sweet even though the concentration is not changed. Several white sugars especially plantation whites contain traces of acid and other flavouring substances, and appear to be somewhat sweeter than the pure refined, although less sweeter than Demerare Yellow. Vegetable (organic) acids and flavouring substances thus appear to aid an increase of sweetness. Proposals have been made that traces of vegetable acids and flavouring substances should be added to pure white sugars for the purpose of increasing their sweetness and palatability as a commercial article.

Experiments carried out with pure sucrose solutions with additions of traces of acids (both vegetable and mineral), and alkalis, have resulted in proving that addition of acids within certain limits enhances the sweetening power of the solution, but when a limit is reached then the acid, bitter or saline becomes apparent. In the same way the addition of traces of alkali depresses the sweetening effect of a solution of the sugar. These experimental results amply corroborate the fact of the difference in sweetness of raw beet and cane sugar. Similar results are also obtained by using salts and bitter substances instead of acids and alkalis. Ordinary common salt and quinine hydrochloride enhance the sweet taste.

Tasting Crystals and Solutions.

Tasting crystals for their sweetness would obviously raise a number of points ; the two sugars would have to be identical in all other points except sweetness. When tasting crystals of sugar the presence or absence of a film of moisture on the crystal is of primary importance as the taste stimuli cannot be excited until and unless the crystal dissolves and produces the solution phase required to satisfy the taste nerve.

On the other hand, the taste when a solution is used is instantaneous. One cause of the apparent increased sweetness of certain good quality gurs in comparison to crystal sugars may be due to the sweet substance of gur being practically in solution. The first cause of apparent superiority in sweetness of gur would thus disappear if both crystal sugar and gur are used in solution weight for weight with equal amounts of water. The second point that may enhance the sweetness apparently is the presence of acids and flavour and these are positive stimuli towards increased sweetness.

After all the levulose is about one-eighth of the amount of sucrose that is present and taking into consideration the threshold concentration of taste and the actual concentration of sucrose and reducing sugars present in gur, there does not appear to be any basis for ascribing the apparent sweeter taste to the presence of levulose alone. Even the presence of levulose, as much as is assumed, is not established and it is an obvious fact that the high temperature (110 to 120°C.) at which gur making is carried out may lead to the destruction of this easily affected monosaccharide which loses its power of rotation and tenacity of constitution even at such low temperatures as 85°C.

The superior sweetness of gur compared to crystal sugar is erroneous, but that good gurs possess a sweet aromatic taste and are very palatable is a fact. Experiments carried out with sugars and gurs by the dilution test apparently lead to the obvious conclusion that any gur is really not sweeter in any degree than pure crystal sugar weight for weight. Assuming that levulose is present, it is equally certain that an equal, if not greater, amount of dextrose is present ; and usually it is a mixture of these two sugars probably in equal amounts in the form of invert sugar that is present.

The Late Sir Charles G. Smith.—We regret to announce the death at the age of 82 of this pioneer colonist, whose name is synonymous with the growth of the sugar industry in Natal. His firm, C. G. Smith & Co., Ltd., controlled by him to the time of his decease, was responsible for the handling of approximately one-third of the total sugar made in Natal and Zululand. He was also interested in the coal trade and in coastal shipping. Sir Charles had been a member of the Natal House of Assembly and of the Legislative Council, and was one of the foremost workers in the establishment of the Union of South Africa. In 1921 he received the K.C.M.G. for conspicuous political and industrial services to the Union.

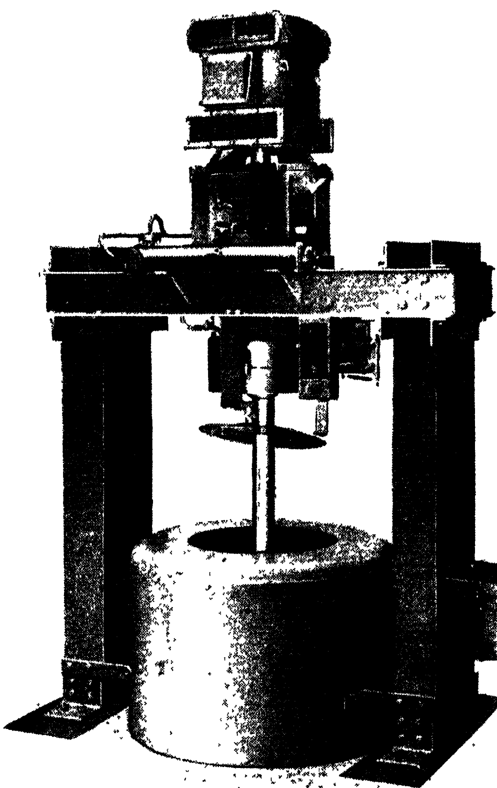
Sugar Uses in the U.S.A.—Figures collected by the Department of Commerce, Washington, show that 40 per cent. of the sugar consumed in the U.S. reaches the individual consumer, not as granulated, but in the form of candy, cake, ice-cream, other food products and beverages. Establishments representing 98·3 per cent. of the commercial food and beverage production reported the consumption in 1939 of 4634 million lbs. of sugar, costing 4·50 cents per lb., the output during the same year of refined cane, beet and corn sugar amounting to 11,983 million lbs. Amounts of different kinds of sugar consumed were : cane, 3246 ; beet, 1079 ; and corn 309 million lbs. The bakery products industry is the largest consuming group.

Cellulose Pulp from Bagasse.—" One of the new industries which might be started in South Africa is the manufacture of cellulose pulp for rayon. It has already been shown that bagasse is quite suitable for this purpose, but it should be borne in mind that bagasse is not the only waste product in this country from which a suitable rayon pulp can be made. Here then is an opportunity to be grasped before it is too late. The sugar industry here is favourably situated for such an enterprise, in that it is possible to obtain coal at a reasonable cost and thus release bagasse for processing . . . At one time artificial silk was made solely from cotton, but intensive research has shown that perfectly satisfactory material can be made from wood pulp . . . Search for other sources of cellulose is still being vigorously prosecuted and into this category comes the cellulose that can be made from bagasse."—Excerpt from Dr. Hedley's Presidential Address at the South African Sugar Technologists' Association Meeting.

Watson, Laidlaw Centrifugals.

A New Application of the Scoop-controlled Hydraulic Coupling.

All who have been closely connected with the sugar industry throughout the world during the last fifty years know the name of "Watson-Laidlaw" and most of these associate that name with the design and manufacture of centrifugal machines. This is not surprising because for more than fifty years centrifugals made by Messrs. Watson, Laidlaw & Co. Ltd., of Glasgow, have been in use in sugar factories and refineries in almost all beet and cane-growing and sugar refining countries. Many of the earlier



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machines made by these well-known engineers are still giving faithful service (as evidenced by an occasional demand for spare parts for batteries of a very early date), but new designs are of course constantly being tried out and developed at the firm's works in Glasgow, and, when found suitable after exhaustive tests, are adapted to the needs of the modern sugar factory or refinery.

It may be observed that the methods of driving centrifugal machines have been many and varied. The earliest machines were friction and belt-driven, and these were later followed by the water-driven and electrically-driven types. In the case of electrically-driven machines, there was a tendency in some early designs to overlook the strenuous conditions imposed on the motors, and some machines were consequently underpowered. The makers of electric motors were not guiltless at that period, because certain of them recommended motor sizes which proved quite inadequate to deal with the almost constant accelerating duty imposed on the motors by the short cycles on which, in many cases, these machines had to operate.

These points have not been lost sight of by Messrs. Watson, Laidlaw in the design of a new suspended electrically-driven centrifugal machine, embodying a vertical spindle scoop-controlled hydraulic coupling, which they have lately placed on the market, after lengthy and extensive tests to ensure that it would give complete satisfaction.

The accompanying illustration shows this machine. It is a 42 in. × 20 in. electrically-driven centrifugal machine with a scoop-controlled hydraulic coupling of the vertical-spindle type, interposed between the electric motor and the spindle of the centrifugal. It is designed to run at 1440/1480 r.p.m. and therefore develops a gravity factor of 1250/1300. It can run, if necessary, on operating cycles as short as two minutes, and the motor is amply powered for this task.

Due to the high duty imposed on the hydraulic coupling by the relatively fast acceleration called for by these short cycles, the oil in the coupling is circulated through an oil cooler. The cooler is the cylindrical vessel visible in the illustration in a horizontal position just above the front channel supporting the motor. The hydraulic coupling is of the scoop-controlled type, that is, the quantity of oil in circuit can be increased or reduced by regulating the position of a scoop tube which picks the oil up from a rotating reservoir formed integral with the casing of the coupling. This control offers a simple method of regulating the rate of acceleration, and provides (when sufficient oil is removed from circuit by the operation of the scoop lever) a low speed for mechanically discharging the basket load by means of a plough.

It is not necessary in this machine to stop the electric motor between cycles. The brake handle and the scoop tube are so interlocked that application of the brake empties the coupling circuit of oil, and this cuts off all torque from the motor to the machine.

The inter-position of the fluid coupling between the motor and the machine precludes the use of the motor as a regenerative brake, so that the efficiency

of the mechanical brake had to receive careful consideration. This brake is of the double strap compensated type, and the brake pulley is very efficiently water-cooled. The supply of cooling water to the brake pulley is interlocked with the scoop of the fluid coupling so that the water-cooling service is turned on and off at the correct period in the working cycles.

The fact that the motor runs continuously reduces the peak switch-on current to quite an appreciable extent, and the use of the scoop provides an easy method of varying acceleration, or even ultimate top speed, should it be desired to make experiments with different grades of sugar at different rates of acceleration and different top speeds. Further, the use of the fluid coupling dispenses with the use of friction slippers and the consequent expense of their replacement and the delays involved in replacing these parts during a crop. It will be clear that no mechanical wear takes place in the fluid coupling.

The machine, as shown by the illustration, does not embody any automatic features, but automatic control of machines of this type can be supplied to suit the needs of the work to be done.

Beet Factory Technical Notes.

Manitoba's First Beet Factory. G. E. Hrudka. *Facts about Sugar*, 1941, **36**, No. 3, pp. 20-24.

In 1939 the Manitoba Sugar Co., Ltd., was formed, its growing area extending from the Emerson boundary north on both sides of the Red River, to north of Winnipeg and west along the Assiniboine Valley. Its factory slices about 2500 tons in 24 hours, and some particulars of the factory installation are as follows :—

A Bingham centrifugal beet pump lifts the beets and flume water 21 ft. into an overhead flume, which sends them through a trash catcher into the washing machine. Two Ogden cutters work with B-9, 46-division knives, and the cossettes obtained are weighed on a Merrick "Weightometer" belt, which discharges into a 14-cell diffusion battery (325 cub. ft.) arranged in a double row.

The resulting raw juice passes through a double tank for cold pre-defecation, after which it is heated to 90°C., and treated with the main dose of milk-of-lime. First carbonatation consists of a Benning type single tank, working continuously, a 5-compartment Dorr thickener being used in the usual way. Filter equipment consists of two "Eimco" steel drum filters of 8 ft. diam. × 12 ft. face. Second carbonatation and sulphitation are conducted in a double tank and sulphur tower with three plate-and-frame presses, each having a filter-surface of 700 sq. ft.

Passing through two pre-heaters, the juice enters the first body of the evaporator at 125 to 128°C. This evaporator consists of a 4-body condenser-less system with a total h.s. of 2800 sq. ft., using steel tubes of 1½ in. diam. and special equipment for rapid circulation. Normal boiling temperatures are 125, 115, 105 and 95°C., the bottoms of the bodies being each dished in order to avoid as much as possible any dead space below the calandria.

A straight 3-boiling system is carried out in six pans of the calandria type, all alike in design and size, having 1000 cub. ft. capacity and a h.s. of 1800 sq. ft. Two pans are used for white, two for intermediate and two for low-grade massecuites, first body vapour being used for the white pans, and second vapour for the others. Central condensation is provided.

White sugar strikes are dropped into a receiving mixer equipped with the Stevens mingler coil, which feeds three W.S.M. Co. high-speed white sugar centrifugals, 40 in. diam. (1600 revs. per min.). Intermediates are similarly handled, using two machines. The low-grade pans deliver into two 1000 cub. ft. Lafeuille crystallizers, and from thence into a receiving mixer equipped with the Stevens coil, lastly dropping into four high-speed centrifugals.

Both affinated intermediate and affinated low-grade sugars are re-melted, passed through a couple of filter-presses and then used with thick-juice for boiling the white sugar strikes. Steam and power plant comprises two 600 h.p bent tube boilers, 3-drum type, each capable of a normal capacity of 45,000 lbs. of steam per hour at 3000 lbs. pressure and 615°F. local temperature. Power is generated by an Elliott turbo-generator back-pressure set working at 3600 revs. per min. and generating 3-phase current of 550 volts, 60 cycles, light being distributed at 120 volts.

Evaluation of Quality and Bacteriological Examination of Granulated (Beet) Sugars. J. C. Keane.[1] *Proceedings of the American Society of Sugar Beet Technologists, 1st Meeting*, pp. 55-57.

The most important characteristic is general appearance in crystalline form, which grading is generally done by visual comparisons with arbitrarily selected sugars, usually under artificial daylight illumination. Preferably, however, the "general appearance" is evaluated by means of the photo-electric apparatus designed by B. A. Brice,[2] the working standard of reflectance of which is an opaque white glass plate with a finely ground surface.

[1] Utah-Idaho Sugar Co. [2] *I.S.J.*, 1937, p. 477.

All the reflectance figures on the sugars examined are reported in their relationship to magnesium oxide, which system of measuring the appearance of a sample of sugar assumes that it is the amount of light which it reflects which is the controlling factor. This is a safe assumption from the standpoint of the consumer, as the reflectance may be lowered by a slight yellowness or greyness of the sugar, or by its large or uneven grain. This objective method gives a numerical evaluation of appearance which is a permanent record.

Ash is determined in the sugars electrometrically by means of a conductivity apparatus, and is regarded as an important factor of quality, though it is recognized that the amount present may not effect the appearance of a sugar. Colour and turbidity of the sugar in solution in water are determined by means of the same photoelectric apparatus as is used for the reflectance measurements, the transmittancy being determined with green and red light without filtering the solution.

Other characteristics which are examined include the extent to which the sugar foams when being dissolved with heat, a method having been worked out for showing this (not here described). Then in a weekly composite sample, the barley test, certain bacteriological tests, and a screening test are carried out. Sulphites are also determined. The barley candy consists essentially in heating the sample of sugar with water under standardized conditions to 350°F. (177°C.), and determining the amount of colour in the resulting mass.

In regard to the bacteriological examination of the sugars, the methods of the National Canners' Association are used, and the sugars must meet the following specifications : (1) For the five samples examined, there shall be a maximum of not more than 150 aerobic thermophilic spores per 10 grms. of sample. (2) For the five samples examined, there shall be a maximum of not more than 75 aerobic flat sour spores per 10 grms. of sample. (3) Anaerobic sulphide spoilage spores shall be present in not more than two (40 per cent.) of the five samples, and in any one sample to the extent of not more than five of these spores per 10 grms. (4) Anaerobic thermophilic hard swell spores shall be present in not more than three (60 per cent.) of the five samples, and in any one sample to the extent of not more than four (65 per cent.) tubes.

Preparation of Ammoniated Sugar Beet Pulp as Protein Food for Ruminants.

H. C. MILLAR.[1] *Ind. & Eng. Chem.*, 1941, **33**, pp. 274-278.

Beet pulp as a feed for livestock is low in protein, but the water-soluble nitrogen in it can be greatly increased by subjecting it to treatment with anhydrous ammonia gas. Its bleached-out appearance is thus changed to an attractive green or brown feed, which is readily eaten by dairy cows and sheep. As the pulp can thus be brought to more than 7 per cent. nitrogen with practically all of the nitrogen in a water-soluble form, it should be possible to convert it at a low cost to a fodder capable of supplying a significant protein portion of ruminants' diet.

Small scale experiments have been carried out to establish the general conditions of the treatment. The apparatus consisted of a steel cylindrical chamber (internal dimensions, 6 in. diam. × 31 in. long), rotatable by being mounted on two motor-driven trunnions. Into this ammoniation cylinder anhydrous NH_3 was admitted from a bomb containing the gas.

A proposed economical procedure for treatment on the commercial scale would use the fertilizer grade of gaseous ammonia, the equipment consisting of a storage tank for the ammonia, appropriate valves and measuring devices, and an iron or steel ammoniation chamber, capable of being rotated. As the amount of nitrogen added to the pulp increases with the temperature of ammoniation, the chamber would be designed according to whether or not an external source of heat would be supplied.

Data shows that if one were satisfied with a product having about 4·0 per cent. of nitrogen, it could easily be obtained commercially by adding slightly more than the theoretical amount of ammonia to the product. If the chamber were insulated, it is probable that a pulp containing more than the stated amount could be obtained, and if it were heated, a yet greater amount could be added. Such a product would be considerably higher in nitrogen than alfalfa hay, for example

That the nitrogen so added to beet pulp is not fixed merely by a neutralization of free acids is shown by the fact that 0·35 ml. of *N*-sodium hydroxide was required in titrating a 10 grm. air dried sample to a pink with phenolphthalein. This added nitrogen was firmly fixed by the pulp, only a small loss was noted on prolonged heating in the oven at 130°C. (266°F.), and no nitrogen losses were detected in samples stored for five months.

Beet pulp ammoniation differs from that of cottonseed hull bran, maple sawdust and flax straw in that a higher temperature is obtained, and much more nitrogen is fixed. As the result of the treatment, its colour is changed from grey to green, brown or black, depending on the temperature employed. Green was not stable for long periods, but the brown and black products were permanent for over twelve months.

An ammoniated sugar beet sample containing 4·4 per cent. of N was readily eaten by dairy cows and sheep, and by year-old dairy stock daily as offered for three weeks. A pulp containing 6·85 per cent. was eaten by sheep when mixed with grains. In some of the tests, a product containing as much as 10·72 per cent. of N was obtained, but it is believed that samples containing less than 6·0 per cent. offer better possibilities as a protein food source for ruminants because of their better colour, odour and palatability. Corn silage can be similarly treated for the increase of its N content, and such a product was readily eaten by year-old dairy stock.

[1] The Quaker Oats Co., Chicago, Ill.

Chemical Reports and Laboratory Methods.

Composition of Defecation Filter Scums. P. J. POLDERMANS and P. J. KLOKKERS.[1] *Archief Suikerind. Nederl.-Indië*, **1**, No. 15, pp. 371-378.

Little is known of the exact composition of defecation filter scums, one of the most complete analysis extant being the following[2] (the figures expressed on the dried sample):

	per cent.
Cane wax	5 to 13
Finely divided bagasse	15 „ 30
Albumin (N × 6·25)	4 „ 5
Pectous substances	1 „ 4
Ash content	20 „ 60
Silica and sand	10 „ 40
Fe_2O_3 and Al_2O_3	1 „ 15
Calcium phosphate	5 „ 15
Magnesium oxide	0·5 „ 2
Sulphate	0·2 „ 1
Unknown substances (as precipitated organic acids)	5 „ 15

This analysis gives a general idea of the composition of the material, but affords very little insight into the composition of the components of the ash. With the object of obtaining further information in this direction, samples of scums were obtained from three different factories in Java: Ketegan (defecation process with muddy juice sulphitation); Kedatonpleret (defecation-sulphitation) and Watoetoelis (defecation-sulphitation).

About 1 lb. of each of these samples was digested with cold water, and well washed on a Büchner filter to remove the soluble organic matter, after which the residue was dried, and its moisture content and "carbonate ash" determined (it being necessary in the case of the Watoetoelis sample to correct the carbonate ash for the SO_3 evolved in its determination). Then a part of the residue was treated with HCl, and an analysis made of the constituents which had passed into solution with the following results:

	Ketegan.	Kedatonpleret.	Watoetoelis.
Moisture (at 105°C.)	7·6	7·9	6·7
Carbonate ash, % dry scums	51·4	58·2	61·7
Constituents, per cent. carbonate ash:			
Insoluble in hydrochloric acid	55·6	56·8	31·0
Silica soluble in HCl	1·8	1·8	3·5
Ferric oxide (Fe_2O_3)	5·4	3·6	3·5
Aluminium oxide (Al_2O_3)	10·7	7·5	8·0
Calcium oxide (CaO)	15·3	13·6	26·9
Magnesium oxide (MgO)	0·4	0·5	0·7
Potassium oxide (K_2O)	1·0	0·8	0·6
Sodium oxide (Na_2O)	2·2	1·7	1·0
Sulphate (SO_3)	trace	0·9	7·1
Sulphite (SO_2)	absent	absent	10·1
Carbonate (CO_2)	„	„	1·0
Phosphate (P_2O_5)	10·8	9·7	5·2
	103·2	96·9	98·6

It is seen from these figures that a large amount of the scums consists of "insoluble in hydrochloric acid." Analysis of this residue showed it to consist in each case mostly of aluminium silicate with smaller quantities of iron and calcium silicates. It would be composed, therefore, of a small quantity of clay, but in the main of silica precipitated in clarification. Part would come from the fine bagasse always present in the raw juice.

In regard to the constituents soluble in HCl, it appeared of interest to ascertain the form in which the P_2O_5 was present, so the P_2O_5 soluble (*a*) in water and (*b*) in citric acid solution was determined. In this way it was deduced that only a little dicalcium phosphate (i.e., the P_2O_5 soluble in water) was present, the greater of the total P_2O_5 being present as tricalcium phosphate, though some ferric and ferrous phosphates and some aluminium phosphate would also be present. It was observed that there was insufficient P_2O_5 to bind all the CaO (other than that combined as silicate), and the possibility is that the excess of CaO is present as organates, or (as is quite likely) in the form of dead-burnt particles from the lime added.

Aconitic Acid in Sediments and Scales. M. A. MCCALIP and A. H. SEIBERT. *Paper read before the Sugar Division of the American Chemical Society, Detroit Meeting, September,* 1940.

In the past few seasons Louisiana sugar factories in certain localities have experienced a peculiar cream-coloured sediment from syrup and various classes of molasses during raw sugar manufacture, which fouls heating surfaces badly and is subject to occlusion in the sugar crystal.

An investigation has proved this sediment to be principally calcium aconitate. A troublesome scale forming on heating surfaces of a refinery vacuum pan and the deposit in a raw sugar house evaporator were found to yield quantities of aconitic acid, the former in a high percentage range.

The aconitic acid was freed from sediment and scale by acidifying with strong hydrochloric acid and extracting with ether. Purification was accomplished by re-crystallization from concentrated acetic acid.

Aconitic acid was identified by its melting point, specific colour reaction with acetic anhydride, and by comparison of its *p*-nitrobenzyl, phenacyl, and *p*-phenyl-phenacyl-esters with the corresponding esters of known aconitic acid. Samples of 1938 and 1939 sediment yielded 56·21 and 57·44 per cent. of aconitic acid, respectively, based on dry material.

Preliminary data obtained on the aconitic acid content of syrups representative of juice from the recently adopted Louisiana cane varieties, Co 290 and CP 29/320, in different localities showed a much

[1] *Volontair* research, carried out at the Experiment Station, Pasoeroean, 1939-40. [2] *Archief*, Mededeeling, 1934, p. 851.

higher concentration of the acid than had been indicated by authors previously reporting its presence in cane juice. Results show aconitic acid to vary rather widely with locality and variety of cane, and there were indications that the kind of cane and the per cent. extraction were also influencing factors.

Since the percentage of aconitic acid on basis of solids is usually higher than that of calculated phosphorus pentoxide (in many cases three times as great), undoubtedly its effect on clarification has been underestimated. Neutralization of this organic acid and heating produce a flocculent precipitate similar to the calcium phosphate precipitate. Concentration causes delayed precipitation in products from juices saturated with calcium aconitate at the lower density.

Principles and Significance of pH Measurement. DOUGLAS M. CONSIDINE. *Chem. & Met. Eng.*, **47**, No. 8, pp. 553-560.

This is a very good general report on the present position of the subject of *pH* measurement, which deserves careful study. Here only some of the more pertinent information will be extracted from it. Colorimetric determinations are subject to several sources of error, as the presence of salts, colloids and proteins, etc., the aggregate effect of which, added to personal errors of colour judgment, may not be inconsiderable.

Much more accurate and definite results are obtained by the electrometric method made possible by measuring the e.m.f. developed by an electric cell, one electrode of which is immersed in the solution of unknown *pH*, while the other is a standard reference electrode. The quinhydrone, antimony and glass electrodes are the primary industrial means of measuring *pH*, and the table below gives the advantages and the limitations of the three types:—

Electrode.	Range of *pH*.	Advantages.	Limitations
Hydrogen	0 to 14·0	Basis of *pH* Measurement. Covers entire range. Not subject to salt error. Low resistence.	Requires supply of pure H gas. Susceptible to poisons. Not good for unbuffered solutions.
Quinhydrone	0 to 9·0	Simple in operation and relatively economical.	Cannot be used in presence of oxidizing and reducing agents, e.g., sulphites.
Antimony	4 to 11·0	Rugged and durable. Can be used in viscous solutions and in the presence of suspensions.	Subject to error in presence of oxidizing and reducing agents. Slightly soluble in acid solutions.
Glass	0 to 14·0	No contamination of sample. Can be used in presence of oxidizing and reducing agents, and in unbuffered solutions. Not subject to poisoning.	Subject to alkaline salt error over 9 *pH*, for which allowance can be made. No other limitations of importance.

As a measuring electrode, therefore, the glass electrode is definitely superior to any of the others. Early forms liable to breakage have been made robust and reliable. Only the glass electrode approaches the hydrogen system in its ability to cover the entire *pH* range. It may be used from 0 to 14, provided Na, K and Li salts are not present in solution, nor is it affected by suspended solids and dissolved gases.

The high resistance of the g.e. presents problems of amplification not encountered with the other types of electrodes, and the amplifier must be designed for long periods of use without any attention whatsoever. Some means must be used of compensating fluctuations in voltages when current is taken from the mains. Then in some systems it may be necessary to use a drying agent in the amplifier tube chamber to prevent surface leakage.

Temperature changes of the test solution may be compensated automatically by placing a resistance thermometer in the solution, in series with the potentimeter slide wire. As it has a high resistence system, the g.e. must be shielded against electrostatic potentials and must be adequately insulated to avoid errors due to current leakage.

It is also important to note that the glass electrode is adaptable not only in indicating *pH* but also for continuously recording it. In control work, the glass and reference electrodes are usually contained in a continuous flow chamber or dipped directly into the process liquor. A recent development is the high temperature glass electrode, which makes use of a special glass giving long life under continuous operation at 50 to 100°C.

Analysis of Boiler Scales and Sludges (using the "Phototester"). F. K. LINDSAY and R. G. BIELENBERG.[1] *Ind. & Eng. Chem.* (anal. ed.), **12**, pp. 460-463. —Recent work in the authors' laboratory on the application of colorimetric and turbidimetric methods to the analysis of waters indicated that if such methods could be applied to the analysis of boiler scale, and like compositions, the time required for analytical results might be materially reduced. In the simplified method the dried sample is ignited, fused with potassium carbonate, dissolved in dilute HCl, neutralized with NaOH, and made up to definite volume. An aliquot portion is taken for each constituent to be determined (Fe_2O_3, P_2O_5, SiO_2, CaO,

[1] National Aluminate Corporation, Chicago.

MgO, SO_3, and Al_2O_3), and suitable reagents added to develop either a colour or a turbidity proportional to the amount of the constituent present. This amount of colour or turbidity is measured by means of the "Phototester," curves having been made by plotting the microammeter reading against the percentage composition, using standard solutions. In the case of various determinations, the reagents which are used for the production of a coloration or turbidity are as follows : Fe_2O_3, thioglycolic acid ; P_2O_5, ammonium molybdate, sodium sulphite and 1-amino-2-naphthol-4-sulphonic acid; SiO_2, ammonium molybdate, sodium citrate, sodium sulphite and 1-amino-2-naphthol-4-sulphonic acid ; SO_4, barium chloride ; CaO, sodium sulforicinoleate and oleic acid ; MgO, calcium chloride and Eastman's titan yellow ; and Al_2O_3, ammonium acetate and aurin tricarboxylic acid. Tabulations of the results obtainable with these methods as compared with the standard time-consuming procedures involving precipitations ot the constituents sought show a reasonable agreement.

The "Hygroscope," for the Rapid Determination of Water in Loose Materials (e.g., Bagasse). *Communicated to this Journal.*—This instrument is based on the principle that the humidity of the aid in the interstices of a loose or fibrous material (such as fibres, grain tobacco, tea or textiles) is a correct indication of the percentage of water present. It is well recognized that air in close contact with a hygroscopic material will in a short time come into equilibrium with the quantity of water present. By measuring the relative humidity of this air, the percentage of water to substance can be determined with accuracy. In the "Hygroscope"[1] the wet and dry bulb method of determining the r.h. of the air in the interstices of the material has been adopted, which method has both accuracy and speed, the time taken for a test being less than three minutes. This instrument is suitable only for testing materials in bulk form with a minimum volume of two cubic feet ; if they are dusty, filters must be provided to ensure that no particles settle on the thermometer bulbs. It costs about £16.

Coal or Oil from Molasses or Other Vege able Materials. Ernst Berl. *Paper read before the Sugar Division of the American Chemical Society, Detroit Meeting, September,* 1940.—Announcement is made of the production of crude oil, bituminous coal, asphalts and coke from grass, leaves, molasses, seaweed, wood, corn or cornstalks, and an attempt will be made to produce anthracite. Contrary to previously held views that true bituminous coals are formed for the most part from the lignin content of plants, it is now regarded as proved that such coals are mostly formed in nature from the carbohydrate contents of plants. It is also said to be proved that asphalts are the parent material of crude petroleum. These transformations have been effected in the laboratory within an hour, which might also happen in nature if the conditions were right. The proposition has little commercial promise at the present time, but it holds out the prospect of a future supply of petroleum products when the supply of raw materials accumulated in past geological ages has been exhausted.

Crystallization of Sucrose from Juices of the Sorgo Plant. E. K. Ventre.[2] *The Sugar Journal* (Louisiana), **3,** No. 7, pp. 23-26.—This is a preliminary report based on two seasons' work of about three months each. The presence of starch is the great difficulty with which the manufacturer of sugar from this source has to contend. After trying three different physical methods for the separation of this impurity, recourse was made to the use of pancreatic amylase for the conversion of the starch to monosaccharides, which gave a practically complete removal. A second difficulty encountered was the presence in the vacuum pan of calcium aconitate, which crystallized out as a "smear" before reaching the saturation point of the sucrose. It was found that if the evaporator syrup were heated to 100°C. these crystals at once formed and could be readily settled. Using a pilot plant, it was found that the process giving the most satisfactory results was as follows : Raw juice centrifuged to remove some of the starch, limed to 8·4 to 8·6 *pH*, heated to b.pt., and settled ; clear juice treated at 6·8 to 7·2 *pH* with amylase (20 grms. per 100 gall.) after flashing to 65°C. ; juice evaporated to 32°Bé., heated and the aconitate separated ; lastly, the syrup boiled to two massecuites to give a raw sugar at 96° and molasses at 30° purity.

Activated Carbon Manufacture from Press Mud. A. Nagaraja Rao and N. S. Jain.[3] *Proc. 9th Conv. Sugar Tech. Assoc., India,* I, pp. 293-302. Press-mud was air-dried, filled into fireclay or iron tubes, and ignited in a furnace, the temperature of which was 800-900°C., heating being continued till the evolution of fumes had completely ceased ; the ignited mass after cooling was treated with HCl to remove mineral matter, washed with water, dried at 105°C., powdered and sieved. Sulphitation factory mud gave 15-18 per cent. of this carbon, and used 1·8 lb. of 33 per cent. HCl per lb. of carbon, its ash, however, remaining 28 per cent. Its *pH* was 6·7. A quantity of 14,000 tons could be produced in India from sulphitation press mud alone. " Every sulphitation factory by setting up a suitable auxiliary carbon unit can dispose of its press mud and simultaneously produce all the carbon required in the factory for treating the juice or the syrup corresponding to its entire production capacity."

[1] U.K. Patent, 517,796.

[2] Bureau of Agricultural Chemistry and Engineering, U.S. Department of Agriculture.

[3] Imperial Institute of Sugar Technology, Cawnpore.

Abstracts of the International Society of Sugar Cane Technologists.

Under the scheme initiated by the International Society, a collection of abstracts of papers on agricultural and technical subjects is prepared monthly. A selection from these "Sugar Abstracts" has been made by us from the material last issued, and is printed below.

CANE AGRICULTURE.

Survey of Cane Agriculture in India, 1939. R. C. SRIVASTAVA. *Indian Trade Journal*, May 30, 1940, Supplement, pp. 2-5.

Much work is being done with new Coimbatore varieties, some of which have failed miserably while others do fairly well. A number of these new seedlings show an increasing tendency to high sucrose content in the winter and spring months. A promising early variety is Co 508 which in Madras has shown a very high sucrose content (16 per cent.) in January-December at the age of nine months and has yielded 39 tons of cane to the acre; it also stands in the field for a long time without much deterioration. In several districts Co 419 is proving superior to POJ 2878.

From results obtained in various districts, a spacing of 3 ft. is recommended for a thin and 4 ft. for a thick variety; in one case a two-foot spacing has given a better yield. Top dressings with nitrogen (N) not exceeding 150 lbs. per acre have been found economical in Bombay-Deccan. In Punjab, 40,000 two-budded setts have been found the optimum rate of planting. A new type of striped cane borer has appeared in Pehra Dun; it attacks the cane at a height of two to four feet above the ground and bores downward.

Comparative Study of Climates suitable for Cane Culture. W. KNOCHE and V. BORSACOV. *Estacion Experimental Agricola, Tucumán, Bulletin*, 1940, No. 30; 19 pages.

The authors have devised a new system of classification of climates. The base of the system is a graph with monthly precipitations as abscissae and temperatures as ordinates. The average temperature and amount of precipitation in a given month thus determine a point on the graph, and this point describes the "thermohydric" situation of that month. By connecting various points that have been fixed in this manner a line or curve is obtained which represents the "climatogram" of the region.

Horizontally, the diagram is divided into five zones, corresponding to (0) cold, (1) sub-temperate, (2) temperate, (3) warm, and (4) torrid. Each of these zones is divided into sub-zones; thus, the warm zone (3) may be moderately warm (3′) or quite warm (3″). The rainfall is sub-divided in an analogous manner: *a* is very dry; *b* dry; *c* dry-humid; *d* humid, and *e* very humid. In all, there are thus five thermal values and five humidity (precipitation) values.

Including sub-divisions, this scheme allows 24 combinations which are sufficient to characterize the various climates of the earth and to permit a direct comparison of the climates of widely separated localities. Thus, the climate of New Orleans is represented by (3′*d*, 4*d*, 3*c*); that of Colonia Popular, Tucumán, by (3′*d*, 3″*d*, 3*c*). The hydric character is the same in both localities, with the difference that spring in the Chaco region is quite warm (3″) while in New Orleans it is torrid (4*d*). The general characters of the climates of various cane producing regions are tabulated as follows :—

Rabaul (New Guinea)	4c	4e	4d
Mackay (Australia)	3b	4e	3′d
Brisbane (Australia)	3b	3″d	3c
Honolulu (Hawaii)	3′d	3′d	3′d
New Orleans (U.S.)	3′d	4d	3c
Miami (U.S.)	3c	4c	3c
Hidalgo del Parral (Mexico)	3a	3c	3b
Monterrey (Mexico)	3b	4b	3b
Vera Cruz (Mexico)	3a	4d	3″d
Habana (Cuba)	3b	4c	3c
Camaguey (Cuba)	3c	4c	3c
Point Morant (Jamaica)	3c	4b	3c
San Salvador (Salvador)	3b	3″e	3″d
Colon (Panama)	4c	4e	4d
Chiclayo (Peru)	3a	3a	3a
Cayenne (French Guiana)	4e	4d	4d
Batavia (Java)	4c	3″d	4d
Malaga (Spain)	3c	3a	3b
Argentina—			
Ledesma	3b	3″d	3c
Ingenio Esperanza	3a	3c	3b
Ingenio San Martin	3b	4d	2d
Tucumán	3b	3″d	3c
Concepcion	3c	3″d	3c
Formosa	3c	4c	3c
San Fco. de Laishi	3′d	4c	3c
Colonia Popular	3′d	3″d	3c
Colonia Benitez	3′d	4c	3c

Factors affecting the Germination of Cane. H. F. CLEMENTS. *Hawaiian Sugar Planters' Record*, 1940, **44**, No. 2, pp. 117-146.

Although the mechanics of planting cane are comparatively simple, involving cutting the stem into short pieces, dropping these into a furrow, and covering them with earth, the operation is one which depends for success on other factors that are internal or external to the seed piece.

One of the most influential of the external factors is temperature. This was proved by planting one set of flats in direct sunlight, another in a well-ventilated

greenhouse, and a third in the heavy shade of some trees. In one series the temperature of the soil in the flats in the open, exposed to direct sunlight, ranged from 75°F. upward to an average daily maximum of 91·8°F., that in the greenhouse from 75°F. to an average daily maximum of 88°F., and that in the deep shade from 69° to 73·4°F.

The highest temperature compares with very favourable field conditions, while the low temperature is about the average condition found in cloudy areas during the winter months. Results of the series of experiments above referred to are given in the accompanying table, the soil temperatures shown being average daily maxima in degrees Fah.

Seed pieces.	Soil temperature.	Per cent. Emergence.	Average Emergence Time (days)
Upper third	91·8	93·3	10·3
	88·0	88·9	12·7
	73·4	50·5	20·4
Middle third ..	91·8	74·4	13·5
	88·0	64·7	13·8
	73·4	31·8	21·9
Lower third	91·8	77·7	13·8
	88·0	66·6	14·2
	73·4	45·2	24·2

It is clear from these data that soil temperatures exert a tremendous influence on the germination process. Germination at 70°F. or slightly above is roughly one half of what it is at the higher temperature, and the time of emergence is nearly doubled. Measurements of soil temperatures in Hawaiian cane fields show a range of 73·4 to 84·2°F. from December to June.

Under such conditions the late fall and early winter are marginal or sub-marginal for germination. However, even in these seasons the upper inch of soil has a tendency to warm up intermittently, which emphasizes the desirability of shallow planting in cool or cloudy seasons.

The two external factors next in importance are soil aeration and soil moisture. The necessity of aeration was demonstrated by planting cane in a warm, moist but badly puddled soil; not a bud emerged. In heavy soils it is advisable to barely cover the seed. In loose, warm soils the depth may be four inches, but deeper planting in such soils in cool seasons resulted in 25 per cent. germination and a 50 per cent. stand. The necessity of moisture is self-evident.

The internal factors that influence germination of seed cane are the age of the seed pieces, their length, position of buds, composition of seed piece, and presence or absence of leaf sheaths (trash). As to age of seed piece, it is well known that body pieces are less desirable for planting than top pieces; the old buds will produce slower growing shoots and a lower germination percentage, and are less successful under unfavourable temperature and aeration conditions.

As to placing the bud in the furrow "up," "down," or "sideways" it was found that the "up" buds, being nearest the surface, came through first; the "down" buds require twice as much time, and the others are intermediate. As regards length of seed piece, the longer it is, the lower the germination percentage and the lower the average shoot vigour. To use pieces with more than three buds is to waste the extra buds. Nearly all the "down" buds are wasted.

The presence of trash (leaf sheath) slows up emergence and reduces germination; whether it will pay to remove the sheath depends on local conditions. As to composition of the planting material, soft and succulent pieces easily rot and suffer damage. Hard material is slow in germination.

It seems desirable to take young cane at six or seven months, "hardened" and treated with nitrogen fertilizer about two weeks before cutting and planting. Soaking in warm water (85 to 95°F.) for 24 or 48 hours gives substantially improved germination and vigour, especially if the water contains about one per cent. of calcium nitrate.

Variety and Fertilizer Position in British Guiana. C. H. B. Williams. *Sugar Bulletin*, 1940, No. 9, pp. 55-62.

There has been a rapid change-over from D 625 to Diamond 10 and POJ 2878, and a welcome drop in the mixed varieties, as shown below:—

Variety.	Per cent. of Total Area 1934	1936	1938	1940
D 625	62·5	44·6	20·6	2·8
Diamond 10	16·8	29·4	41·3	37·1
POJ 2878 ..	1·4	9·7	31·7	57·6
"Mixed"	9·5	12·7	4·0	0·6

Diamond 10 seems to have reached a maximum and to be declining but POJ 2878 continues to spread. Commercial returns confirm the experimentally demonstrated superiority of POJ 2878. Small commercial tests with D 49/30, D 66/30 and Co 213 have given promising results.

Imports of ammonium sulphate (11,720 tons) in 1939 were a record and those of pulverized limestone (4795 tons) the second highest on record. Limestone has completely replaced slaked lime as a soil amendment. Imports of other fertilizers, mainly superphosphate and basic slag, only amounted to 2033 tons and the trend is downward.

Overhead Irrigation at Waialua, Hawaii. H. R. Shaw. *Hawaii Farm and Home*. 1940, **3**, No. 7. pp. 5 and 17.

On an experimental field of 106 acres permanent water supply lines were laid in the ground with hydrants at convenient intervals. When it became necessary to irrigate the field portable sections of pipe were connected to the hydrants and water was applied through sprinkler heads spaced 80 ft. apart in windy weather and 100 ft. during still air conditions (night). Pressure was supplied at 75 lbs. to create a flow of 1300 g.p.m.

Usually 30 sprinklers were operated at one time, and when that section had received sufficient water

the portable pipes were disconnected and moved to another location. The operation was repeated when necessary; as the cane grew the pipes were supported on portable raisers so as to throw the water over the top of the cane. The system allows of irrigating 300 acres or more by one man in one day. This system of movable pipe is regarded as more practicable and less expensive to install than the more familiar one of having fixed pipes leading to the fixed sprinklers. Various advantages of the system are indicated.

BEET TECHNOLOGY.

Estimating Sugar Colorimetrically with Concentrated Sulphuric Acid. J. PELTZER. *Chemiker Zeitung*, 1940, **64**, pp. 122-124.

If a 0·005 to 0·02 per cent. solution of glucose, fructose, lactose or sucrose is mixed with twice its volume of concentrated sulphuric acid there is obtained a violet-red colour, which may be used in a colorimetric determination of these sugars. If only an equal instead of a double volume of concentrated sulphuric acid is used, only fructose and the fructose component of sucrose react to produce a fine honey-yellow colour; glucose and lactose are not affected. This provides another means of detecting fructose and sucrose in the presence of the other sugars. The most suitable concentration is 0·5 to 5 mg. of fructose or sucrose in 10 c.c. of solution.

Use of Hydrosulphite in the Sugar Industry. K. ZERT. *Listy Cukrovarnicke*, **58**, No. 51-52, pp. 318-320; *Deut. Zuckerind.*, 1940, p. 657.

As a reducing agent sodium hydrosulphite has been used for a long time, and its action is much stronger and more effective than that of sulphur dioxide or its compounds. Its action consists in bleaching the juice and in a reducing action that prevents the juice from darkening; its action depends on the formation of so-called leuco-compounds which are produced by reduction of the colouring matter. Experiments have shown that hydrosulphite is not a complete substitute for active carbon, but that when the two are used successively a very strong effect is obtained.

It has lately been found that hydrosulphite is used with the most success for decolorizing syrup. It can also be used for bleaching the thick-juice in the last effect of the evaporation station, or as an addition in the thick-juice supply tank. An important point to observe is that the hydrosulphite should be added when the syrup or juice has a temperature that does not exceed 50 to 75°C. Its mixing with syrup or thick-juice should be very thorough.

Apparatus for registering Optimal Alkalinity of the Last Carbonatation. V. STANEK and P. PAVLAS. *Listy Cukrovar.*, **58**, No. 49-50, pp. 297–304; *Deut. Zuckerind.*, 1940, p. 600.

It is well understood by beet sugar technologists that in order to obtain a thin juice of the best colour and lowest lime salt content it is necessary rigidly to maintain the optimal alkalinity during the second carbonatation. However, the optimal alkalinity has a habit of changing, because it is continually dependent on the character of the juice. The authors have therefore undertaken the construction of an apparatus that would enable the operator to inform himself whether he is carbonatating properly.

The apparatus and procedure are based on the following circumstances: When calcium chloride is added to titrated second carbonatated juice a precipitate is thrown down. When to this mixture there is added some ammonia, the amount of the precipitate is increased if the juice happens to contain any bicarbonate; that is, the ammonia converts the bicarbonate of lime into carbonate and thus increases the amount of suspended lime carbonate thrown out by the calcium chloride. This increases the opacity of the liquid, and the increase in opacity can be registered by a photo cell.

Along this line a method and apparatus have been worked out, according to which the operator, at intervals of 10 minutes or less, measures a certain amount of the filtered juice and intimately mixes it with a certain amount of a standard calcium chloride solution. The mixture then flows into a cuvette where the amount of the precipitate is measured by means of a photo cell. Then the mixture is drawn through a rubber tube into a second mixing vessel where a certain amount of ammonia is mixed in. From here the mix goes into a second cuvette where the amount of precipitate is again measured by the photo cell. If the juice has been properly carbonatated the two measurements will agree. If not, the carbonic acid gas valve is suitably readjusted. The ammonia used must naturally be free from carbonate. To secure a finely dispersed precipitate, some gum arabic (2·5 per cent.) is mixed with the calcium chloride solution. The system has been thoroughly tested both in the laboratory and in the factory; the results are described as good, and the method seems to be ready for industrial use.

Influence of Size of Beets on Factory Quality. N. SZENDE, R. VADAS and B. EXNER. *Deut. Zuckerind.*, 1940, **65**, p. 353.

Normally, when the stand or density of planting is equivalent to 10 plants per sq. metre, the beets will weigh between 400 and 600 grms., depending on the fertility and moisture conditions of the soil; but when the same variety is planted under similar growing conditions on different kinds of soil, the size may vary up to 2,000 grms. Similar variations are observed on the same field where the stand is irregular and shows large gaps.

These variations in size are accompanied by variations in chemical composition and factory quality. From the factory standpoint the large beets are worth less than the medium and small ones, not only on account of their lower sugar content, but also on account of their generally higher content of harmful nitrogen and ash.

New Books and Bulletins.

Canning Practice and Control. OSMAN JONES, F.I C, and T. W. JONES, B.Sc. (Chapman & Hall, Ltd., London). Second Edition. 1941. Price : 32s. net.

After the comparatively short intervals of three years, a second edition of this book has been demanded, developments in canning practice having been both rapid and varied. Very little of the first edition had to be modified, but considerable additions have had to be made, these being principally noticed in Chapters III, IV VI, VII, IX, XIII and XIV.

Chapter III, headed "Canning," has been considerably extended. This was necessary to describe developments in all branches of the subject from the manufacture of tin-plate right through to the consideration of hydrogen swells. Among notable advances may be mentioned the continuous strip mill, "high short" sterilization, fruit juice canning, and the continuous pressure cooker cooler.

Chapter IV, which is headed "Packing Foods in Glass Containers," is a completely new one, and is included because it deals with a practice which is now being undertaken by many canneries at the present time. Chapter V remains as originally written, as does also VIII. Chapters VI, VII and IX treat of the examination of raw foodstuffs, the can or glass, and with the examination of canned foods. New analytical methods have been added in these sections, while Chapter XIII has been expanded considerably by the addition of recent work on the thermophilic organisms. Chapter XIV includes an account of new work on the effect of canning on nutritive values. Other chapters, as already indicated, remain substantially as in the first edition. Since the publication of the first edition in 1937, this book has become to be regarded as a most valuable contribution to the subject, being authoritative and remarkably complete. Additions to this new edition will further enhance its value.

Chemical Computations and Errors. THOMAS B. CRUMPLER, Ph.D., and JOHN H. YOE, Ph.D. (Chapman & Hall, Ltd., London). 1940. Price : 18s.

It is certain that every chemist should have at least a working knowledge of mathematics. He should be able, not only to use formulae, and apply various methods of computation, but he should know how to interpret numerical results. In colleges and universities insufficient attention appears generally to have been devoted to suitable courses of training in mathematics for students of pure and applied chemistry.

This book by two American professors of chemistry, the first at Tulane, Louisiana, and the second at Virginia University, is intended to be used by chemical undergraduates, either as a textbook for a course in computations and errors, or it may be used as a supplementary textbook in a regular chemical curriculum course. And especially may it serve as a manual for home study to the many chemists who have not had the opportunity of receiving sufficient training in the topics presented.

Chapter I deals with computation methods (exponential numbers, logs and slide rule); II with the estimation of significant figures; III, IV, V with solving of equations, interpolation and extrapolation. This forms the first third of the book, and is of an elementary character. The second third (Chapters VI, VII and VIII) discusses more advanced matters such as the theory of measurements, the classification of errors and modern statistical methods. The remainder of the book (Chapters IX, X and XI) covers yet more advanced mathematical considerations, such as the theory of errors, the statistical interpretation of measurements and "curve fitting"

Throughout the text there is a good selection of material used for examples and exercises, which forms a useful feature in a volume of this sort Chemists generally, not only those connected with the physical and biological sides of the subject, will find such a book as this a welcome guide. Its subject matter on the whole is very clearly presented, and it can be well recommended to those chemists desiring to acquire an insight into the statistical interpretation of their measurements.

Reports of the Progress of Applied Chemistry. Vol. XXV. (Society of Chemical Industry, London). Price 7s. 6d. to Members; 16s. to others.

This year the Report on "Sugars" is contributed by Dr. E. B. HUGHES, F.I.C., who with clearness summarizes the progress made in our industry during 1940 in cane and beet sugar manufacture. "Soils and Fertilizers" is again written by G. V. JACKS, M.A., of the Imperial Bureau of Soil Science. "General Plant" is by M. B. DONALD, M.Sc., M.I.Mech.E.; and the "Fermentation Industries" by Dr. ALAN A. D. COMRIE, F.I.C. These reports maintain the high standard of previous years.

The Sugar Cane Farm. HAROLD HOFFSOMMER. Louisians Bulletin No. 320. (Louisiana State University; Agricultural Experiment Stations).

This study aims to describe from the social point of view the labour and tenancy arrangements on Louisiana sugar cane farms, and has been compiled in co-operation with the tenure and labour relations section, Division of Programme Planning, Agricultural Adjustment Administration, U.S. Department of Agriculture.

Sugar-House Practice.

Correlation between the Properties of Sulphitation Juices and Syrups and the Colour of the Sugars produced from Them. H. E. EVERARD.[1] *Archief Suikerind. Nederl.-Indië*, **1**, No. 13, pp. 309-317.

For a number of years past the Experiment Station at Pasoeroean, Java, has had an arrangement with chemists and others employed in the sugar factories in that country to carry out *volontairs* investigations "for the benefit of the industry," and the present paper describes the results of some chemical experiments conducted according to this scheme.

Its theme is the reducing power of clarified juices and syrups in the sulphitation factory, and the significance of this in connexion with the colour of the white sugars produced. But by "reducing power" is meant the reducing power as determined with iodine, not with Fehling's solution. This value, therefore, has nothing to do with the content in reducing sugars. It concerns the rôle of the SO_2.

In preliminary experiments carried out on a semi-technical scale, the behaviour of the SO_2 in juices and syrups was studied by determining their reducing power towards iodine before and after passing air into them. It was found that the effect of the air was to diminish the reducing power of the product towards iodine, the SO_2 being almost entirely eliminated as such.

Colour extinction figures for the sugars obtained from heavily sulphited syrups indicated that a large excess of SO_2 may even exert a harmful influence on the colour of the sugars. Some of this excess SO_2 may undergo reduction to sulphuretted hydrogen, which may form dark-coloured sulphides with traces of iron and copper present, and thus adversely affect the whiteness of the sugars, imparting to them a greyish hue.

Later these investigations were extended to the factory, where the special points under examination were : (1) whether, if reducing substances are expelled from sulphited juices and syrups in the evaporator and pans, they can be found again in the condensates ; and (2) whether there exists any connexion between the amount of reducing substances thus expelled, and the colour extinction of the sugars obtained from these products.

Samples of clarified juices and evaporator syrups were placed in a suitable flask, and bubbles of air drawn through them for a period of about 15 min., a "juice-catcher" flask being interposed to trap any entrainment likely to be carried over. After determining the *pH*, the reducing power of the sample towards $N/10$ iodine was determined before and after such air treatment.

Working in this way, the reducing power of juices was found to be : (*a*) before air treatment, from 192 to 512 mgrms. of SO_2 per litre ; and (*b*) after treatment, from 160 to 448 mgrms. Corresponding figures for the syrups were : (*a*) from 1152 to 2432 mgrms., and (*b*) from 1024 to 2272 mgrms. Generally the *pH* remained the same after the air treatment.

Figures were thus obtained leading to the conclusion that the amount of reducing substances expelled during evaporation can be found again almost entirely in the condensates, the fall-water of the central condenser, and the boiler-feed water. Lastly a graph was presented to show that a higher reducing power of the condensates is directly related to an inferior colour, i.e., a high extinction, of the white sugars produced.

Drying and Hardening of Soft Sugar. K. DOUWES DEKKER. *Archief Suikerind. Nederl.-Indië*, **1**, No. 17, pp. 455-458.

If water be evaporated from the layer of syrup surrounding the raw sugar crystal, the sucrose present in this syrup passes into the state of supersaturation, and sucrose will crystallize out; it does not all deposit on the existing crystal, but forms new fine crystals, which cause the grains to cement together. This effect may be heightened by the viscosity of the syrup, though this is not so always. It is clear that the more sucrose crystallizing out (depending on the evaporation taking place and on the amount of syrup present), the greater the hardening.

Conditions controlling the hardening of raw sugars have previously been studied by the author,[2] when it was shown that the relative vapour tension of the sugar is closely correlated with the safety factor, the drying of the sugar taking place only when the relative vapour tension of the sugar is greater than those of the surrounding air. But in order to go more closely into the matter, the effect of the amount of syrup, and of the invert sugar present in this syrup, was studied.

This was done by baking a number of small cakes of sugars of varying syrup content, and of different invert-to-moisture ratios. Crystals of pure sugar were mixed with an invert-containing syrup of known composition, so as to provide six raw sugars of the following percentage proportions of invert sugar and moisture : (1) 2·0, 2·0 ; (2) 2·0, 1·0 ; (3) 4·0, 4·0 ; (4) 4·0, 2·0 ; (5) 6·0, 6·0 ; and 6·0, 3·0 per cent. These sugars were moulded into small cakes by placing them in a round tin shape, 100 mm. diam. and 15 mm. deep, and moderately pressing them down. Next, the cakes were exposed to atmospheres of four different humidities (in desiccators containing sulphuric acid of 41·6, 37·4, 32·0 and 26·2 per cent. H_2SO_4 concentration). Then, always proceeding in the same way in each of the tests, and at the same temperature, the weight necessary to break each cake

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[1] Of the Djombang s.f., Java.

[2] Java *Verhandelingen*, 1936, No. 16.

No. of Sugar, and invert to moisture ratio.	Relative Humidity. 54 per cent.	62·2 per cent.	74·2 per cent.	81·6 per cent.
Sugar No. 1 2·0, 2·0	**>5000 grms.** On breaking up by hand, feels loose and very dry.	**2227 grms.** On breaking up by hand, feels loose and very dry.	**558 grms.** Feels rather stickier than previous test, and somewhat soft.	**262 grms.** Feels soft and kneadable, no longer original shape.
Sugar No. 2 2·0, 1·0	**936 grms.** On breaking up by hand, appears to be quite soft.	**438 grms.** Feels very soft almost as original sugar, somewhat drier.	**321 grms.** Already soft, had not properly hardened.	**308 grms.** This sugar was quite soft.
Sugar No. 3 4·0, 4·0	Very much more than **5000 grms.** Entirely hardened, Cannot be broken up by hand, dry.	**>5000 grms.** Somewhat less hard than the previous test.	**1061 grms.** Though hardened can be broken up fine, then softer than previous test.	**397 grms.** Had not hardened, soft and moist.
Sugar No. 4 4·0, 2·0	**1766 grms.** Slightly hardened, easily crushed.	**686 grms.** Hardly hardened.	**262 grms.** No hardening, as original sugar.	**233 grms.** As in the previous test.
Sugar No. 5 6·0, 6·0	**>5000 grms.** Top stone was hard, underneath was soft and moist.	**>2400 grms. <5000 grms** Much the same as before.	**1100 grms.** A little hardened on the surface, elsewhere moist and soft.	**400 grms.** Not at all hardened, very soft.
Sugar No. 6 6·0, 3·0	**>5000 grms.** Hardened throughout, yet easily crushed by hand.	**833 grms.** Slightly hardened, somewhat dry and soft.	**400 grms.** Not at all hardened.	**302 grms.** Not at all hardened, had become moist.

was determined, the results being summarized in the accompanying table.

Conclusions to be drawn from these tests are that the sugars having the invert-to-moisture ratio of 2 : 1 had hardened considerably less than those with the ratio 1 : 1; that the higher invert contents were correlated with greater hardening, the invert-to-moisture ratio being the same; and that with a ratio of 2 : 1 exposure of the sugar to an atmosphere of 62 per cent. relative humidity had not resulted in any considerable hardening. From these tests it would appear that in practice one should take care that the ratio of moisture : invert is kep below 0·5.

Splitting of Brass Evaporator Tubes. J. F. Bogtstra.[1] *Archief Suikerind. Nederl.-Indië,* **1,** No. 2, pp. 35-38.

In one of the Java sugar factories a considerable number of the brass evaporator tubes were found to have split, mostly a few cms. above the bottom tube-plate. These cracks had occurred mostly crosswise, though a few were in a lengthwise direction. Neither the origin nor the age of the tubes was known, though the latter must have been at least five years. It should also be mentioned that the factory applied the sulphitation method of juice purification.

Analysis of the tubes (carried out at the Experiment Station) gave : copper, 70·59 ; tin, 1·21 ; lead, 0·03 ; iron, absent ; and zinc, 28·17 per cent. Sections of the tubes (1 × 3 cms.) were cut, polished and etched (with a drop of solution containing HCl per 500 c.c. of water), when it was noticed that the reaction was very slow, taking quite 20 min. (instead of 2 to 10 min., as normally) before a distinct pattern could be seen. This pointed to hard material, and besides this the irregular size of the crystals was striking.

A further examination of the defective tubes was carried out according to the specifications of the American Society for Testing Materials, the results of the elongation test being of the following order :—

	per cent.
Part fitting inside the bottom tube-plate	>20
25 mm. above the bottom tube-plate	5
100 mm. ,, ,, ,, ...	10
240 mm. ,, ,, ,, ...	10
240 mm. below the top tube-plate	12
100 mm. ,, ,, ,, ...	>20
Part fitting inside the top tube-plate	>20

It follows from these figures that, while the extremities of the tubes showed a sufficient elongation (20 per cent. being the standard), the middle parts were inadequate in this respect. It appeared also from the tests made with sound tubes that they had lost their elongation in that part most subject to splitting, namely a little above the bottom tube-plate.

Tests were made to determine the hardness of the metal, which was found to average B-85 Rockwell in the middle of the tubes and B-36 at the ends. This pointed to the ends having been annealed. According to the report of the firm undertaking these hardness tests (corroborating results were obtained at the Proefstation) the breaks were intercrystalline, and were probably caused by corrosion.[2]

[1] *Proefstation voor de Java-suikerindustrie, Pasoeroean.* [2] For a previous case of intercrystalline splitting see *I.S.J.*, 1939, p. 113; and for other literature on the subject of defects of brass evaporator tubes see 1929, p. 612 ; 1932, p. 151 ; and 1933, p. 36.

It was concluded from the general circumstances of the case that corrosion of the metal had taken place, concentrated mostly on the part of the tubes just above the bottom tube-plate. Possibly contact with iron rust may have assisted this action. Undoubtedly the metal had originally been too hard, and probably in most cases the ends had been heated at the factory to make them softer.

In order to guard against such occurrences in the future, the factory was advised when ordering to specify brass tubes containing 70 per cent. of copper and 30 per cent. of zinc, capable throughout their length of giving an elongation of 20 per cent., and at the same time showing an even crystalline structure with an average size of crystal of 0·035 mm. Metallic impurities, as lead and iron, should not exceed more than 0·075 and 0·06 per cent respectively. These in fact are the requirements recommended by the A.S.T.M. for condenser tubes, which have been found by experience also to suffice for evaporator tubes.

Cane Washer Effluent. ALLAN R. DUVALL. *Reports of the Hawaiian Sugar Technologists, 3rd Meeting*, pp. 103-106.—In Hawaii the use of washing plants for dealing with grab-harvested cane is now established, and attention is being turned to a related problem, namely the handling of the cane washer effluent. It contains: trash (leaves and tops, weeds, etc.); rocks (of all sizes); sand and soil particles (including colloidal clays). In order to deal with such material, it will be necessary to borrow the methods and machines which have been found practicable in some other industries, e.g., metallurgy and sewage disposal. A variety of units can be used for removing the large trash pieces, the bar sceen being typical of these, while removal of fine floating trash lends itself to fine screening. Sands settle out very quickly, and could effectively be handled by the "Hydro-separator" of the metallurgical industry, or by the "Detritor" of sewage practice. The former apparatus is fundamentally an undersized single compartment Dorr Thickener, and the latter a shallow square tank with grit collecting mechanism.

pH of Imbibition Water, and some of its Effects. J. R. MAYO, Jr. *Proc. 13th Conf. Assoc. Sugar Tech. Cuba*, pp. 225-226.—Water as used for imbibition is mainly the product of repeated evaporation and condensation of the water content of the juice, and as the result of the decomposition of entrained sugar, one would expect it generally to have a *pH* lower than 7. However, the *pH* of such condensate water has been found to be as high as 8 to 9, and sometimes even more, due doubtless to the accumulated ammonia content of the vapours. It is therefore not possible always to attribute the abnormal wear of intermediate carrier chains and the like to contact with acid juice. It is much more likely that an increased abrasion in the later mills of the tandem might be caused in many instances by drier particles of fibre, dirt and grit. Similarly, one should consider the neutralizing effect of an imbibition water of high *pH* in connexion with studies of the aseptic condition of the milling train.

Filter-Media. F. J. VAN ANTWERPEN. *Ind. & Eng. Chem.*, 1940, **32**, pp. 1580-1584.—Those discussed are: "Vinyon" fabric, a vinyl resin yarn, i.e., a thermo-plastic material, which softens when used with solutions hotter than 150°F. (65°C.), but possessing some qualities of durability and resistance making it superior to cotton cloth. "Multipore," a latex product containing filter holes of microscopic size running straight through the rubber sheet; and microporous rubber, a sheet of spongy texture made up of interconnecting pores of microscopic size. "Multipore" has been used successfully for syrup filtration, and microporous rubber is also said to have been applied in the sugar industry. Wire cloth is also discussed.

Application of the Lost Juice Factor to Mill Control in Cuba. H.D.LANIER. *Proc. 13th Conf. Assoc. Cane Sugar Tech. Cuba*, pp. 191-193.—An example is given of the factor, undiluted juice lost in bagasse per cent. fibre in cane, assuming that two mills operating in different zones are both obtaining 95·71 sucrose extraction with a cane containing 14·0 per cent. sucrose, the fibre at one mill (No. 1) being 10 per cent., and at the other (No. 2) 14·0 per cent. pertinent data being as follows :—

	Mill No. 1.	Mill No. 2.
Sucrose in Cane	14·00	14·00
Fibre in Cane	10·00	14·00
Sucrose Extraction	95·71	95·71
Sucrose extracted, per cent. cane	13·40	13·40
Sucrose lost in bagasse, per cent. cane	0·60	0·60
Bagasse, per cent. cane	20·00	28·00
Sucrose in bagasse	3·00	2·15
Factor : Lost juice, per cent. fibre	40·66	29·94

Normal juice composition was the same in both cases, i.e., Brix, 19·97; sucrose, 16·58; and purity 83·03; but the residual juice for No. 1 mill would be Brix, 3·97; sucrose, 2·94; and purity, 74·00; and for No. 2 Mill, Brix, 3·24; sucrose, 2·33; and purity, 72·00. Volume of fibre passing through Mill No. 2 was 4 arrobas more per 100 arrobas of cane ground than for Mill No. 1, so it can be seen that the sucrose in the bagasse must be lower to obtain the same percentage of sucrose lost per cent. cane, shown as 0·60. While the sucrose extraction does not show it, it is very obvious Mill No. 2 did considerably better work than No. 1, this being clearly and definitely shown by the factor lost juice per cent. fibre.

"BITUMOL."—A product under this name is being offered in Queensland as a road-making material. It contains molasses as a component, and is prepared by the Molasses Products Pty., Ltd., of Babinda.

Stock Exchange Quotations of Sugar Company Shares.

LONDON.

Company	Quotation June 20th 1941	Quotation May 20th 1941.	1941 Dealings Highest. — Lowest.
Anglo-Ceylon & General Estates Co. (Ord. Stock)	24/0 — 25/6	24/0 — 25/6	25/3 — 24/3
Antigua Sugar Factory Ltd. (£1 Shares)	⅜ — ⅝	⅜ — ⅝	11/3 — 8/9
Booker Bros., McConnell & Co. Ltd. (£1 Shares)	2⅜ — 2⅝	2⅜ — 2⅝	52/6 — 47/6
Caroni Ltd. (2/0 Ord. Shares)	1/0 — 1/6	1/0 — 1/6	1/2¾ — 1/0
(6% Cum. Pref. £1 Shares)	21/9 — 22/9	21/9 — 22/9	22/6 — 20/3
Gledhow-Chaka's Kraal Sugar Co. Ltd. (£1 Shares)	$1\frac{3}{16}$ — $1\frac{5}{16}$	$1\frac{3}{16}$ — $1\frac{5}{16}$	24/6 — 22/0
Hulett, Sir J. L. & Sons Ltd. (£1 Shares)	25/3 — 26/3	24/3 — 25/3	26/0 — 22/1½
Incomati Estates Ltd. (£1 Shares)	$\frac{3}{16}$ — $\frac{5}{16}$	$\frac{3}{16}$ — $\frac{5}{16}$	— — —
Leach's Argentine Estates Ltd. (10/0 units of Stock)	5/0 — 6/0	5/9 — 6/3	6/6 — 5/0
Reynolds Bros. Ltd. (£1 Shares)	34/6 — 36/6	35/0 — 37/0	38/0 — 32/7½
St. Kitts (London) Sugar Factory Ltd. (£1 Shares)	1⅝ — 1⅞	1⅝ — 1⅞	35/0 — 34/3
Ste. Madeleine Sugar Co. Ltd. (Ordinary Stock)	13/0 — 14/0	13/0 — 14/0	14/3 — 11/9
Sena Sugar Estates Ltd. (10/0 Shares)	3/9 — 4/9	4/9 — 5/9	6/1½ — 4/10½
Tate & Lyle Ltd. (£1 Shares)	2⅝ — $2\frac{11}{16}$	49/9 — 50/9	51/6 — 46/0
Trinidad Sugar Estates Ltd. (Ord 5/0 units of Stock)	5/3 — 6/3	5/0 — 6/0	5/7½ — 5/0
United Molasses Co. Ltd. (6/8d. units of Stock)	24/4½ — 24/10½	23/7½ — 24/1½	25/1½ — 21/9

NEW YORK (Common Shares).†

Name of Stock.	Par Value.	Closing Price May 31st, 1941.	1941. Highest for the Year	1941. Lowest for the Year
American Crystal Sugar Co.	No par	14⅛	14½	9½
American Sugar Refining Co.	$100	15	19	13
Central Aguirre Associates	No par	16¾	22¾	16¼
Cuban American Sugar Co.	$10	4⅛	5¼	3½
Great Western Sugar Co.	No par	23¼	26⅜	19⅞
South Puerto Rico Sugar Co.	No par	15¼	21	15¼

† Quotations are in American dollars and fractions thereof.

United States, All Ports.

(Willett & Gray)

	1941 Long Tons	1940 Long Tons.	1939 Long Tons.
Total Receipts, January 1st to May 10th	1,900,470	1,424,968	1,524,577
Meltings by Refiners ,, ,,	1,659,803	1,357,776	1,444,471
Importers' Stock, May 10th	118,139	78,472	28,855
Refiners' Stock ,, ,,	389,223	425,289	251,233
Total Stock ,, ,,	507,362	503,761	280,088
	1940	1939	1938
Total Consumption for twelve months	5,712,587	5,648,513	5,604,051

Cuba.

(Willett & Gray)

	1941 Spanish Tons.	1940 Spanish Tons	1939 Spanish Tons
Carry-over from previous crops	1,184,393	588,293	729,172
Less Sugar for Conversion to Molasses	70,949	— —	— —
	1,113,444	588,293	729,172
Production to May 10th	2,390,000	2,745,000	2,690,000
	3,503,444	3,333,293	3,419,172
Exports since January 1st	1,085,965	917,715	943,368
Stock (entire Island) May 10th	2,417,479	2,415,578	2,475,804

Centrals grinding, 7, against 4 in 1940.

Mauritius Sugar Crop in 1939.

The Report of the Department of Agriculture of Mauritius for the year 1939 states that weather conditions during that year were greatly disturbed. The growing season began with a drought which lasted till the middle of February; good rains were then received but the effects were offset by the occurrence of a cyclone in March which inflicted pronounced damage on the standing crop.

The amount of cane reaped was approximately 2,100,000 metric tons or 22 per cent. decrease on the previous crop. The average sucrose content was only 12·71, as against 13·87 in 1938, and the average extraction 10·8 of sugar per cent. cane, as against 11·95 in 1938. The amount of sugar produced was 229,460 tons, a drop of 29 per cent. as compared with 1938. Of this 85·5 per cent. was raw sugar, 14·3 per cent. granulated whites and 0·2 per cent. low sugars.

At the beginning of 1939 the area under sugar cane was estimated at 146,381 acres, of which 103,051 acres were estate cultivation and 43,330 acres consisted almost entirely of lands owned and worked by Indian small proprietors. The total area cultivated by Indians was 55,823 acres or 38 per cent. of the total island cultivation.

In 1939 market conditions were better than during the previous year, the average selling price approximating to Rs. 6·80 per 50 kilos. Exports for the year ending July 31st, 1939, amounted to 308,909 metric tons, of which 2,341 tons went to Hong Kong and the rest to Great Britain. Local sugar consumption for the same year was 12,197 metric tons.

Caterpillar Tractors.

Three new types have recently been added to the products of the Caterpillar Tractor Co., of Peoria, Illinois; "D6," of 55 h.p. at drawbar, built in two gauges—74 in. and 60 in.; "D7," of 80 h.p. at drawbar, gauge of track 74 in.; and "D8," 113 h.p. at drawbar, with a track gauge of 78 in.. To mention D6, which weighs 8 tons, it has hydraulic pressure steering, so is easy to handle, and is fitted with nine practical working speeds, of which five are forward, giving a range from 1·4 to 5·8 miles per hour. The engine which is completely sealed against dust and dirt is 6-cylinder, water-cooled.

Details of these new types can be gleaned from a "Condensed Catalog, 1941" issued by the firm, which lists more than 50 products manufactured by them. As usual with this Company's booklets, it is illustrated in very high-class style.

The Caterpillar Tractor Company recently made some search into the history of the earliest-built "Caterpillar" Diesel Tractors and found that of the first 25 manufactured, 24 are still operating, either as tractors or as power units. Amongst them we note was No. 22 which was supplied to the Central Aguirre Sugar Co., of Puerto Rico, in 1932. This is reported as still in first-class condition after 12,112 hours heavy duty work in the cane plantations. No. 3 went to the Oahu Sugar Co. in T.H., where it has done to date 18,000 hours of tough sugar plantation jobs. Of the rest, a fleet of ten were bought by a Belgian contractor in 1932 to help to make the Albert Canal.

Brevities.

THE AUSTRALIAN 1941 SUGAR CROP.—The Queensland Government is anxious that a peak sugar crop of 737,000 tons should be obtained this year, but there is some uncertainty with regard to the export outlook and whatever shipping is available is likely to be very much spread over the months of the year. For this reason millers were urged to make a start before May was out, so that opportunities for shipment of export sugar could be taken advantage of in early June. But in any case a considerable amount of sugar storage is expected to be inevitable.

WORLD SUGAR PRODUCTION, 1940-41.—Lamborn of New York lately gave the estimate of the world's sugar production during the current crop year, ending August 31st, 1941, as 30,237,000 long tons, raw sugar value, as compared with 30,974,000 tons in 1939-40, a decrease of approximately 2·4 per cent. The 1939-40 crop was the largest on record. World sugar consumption for the 1940-41 year they forecast at 29,295,000 tons (as compared with 29,819,000 tons in 1939-40), a figure which if established will show the smallest consumption in the past five years. The decrease is due to sugar rationing in practically every European country. Excluding Russia, Europe's decrease in consumption since the war broke out nearly two years ago is estimated by these statisticians as 1,600,000 tons. World sugar stocks at September 1st, 1940, amounted to 11,424,000 tons, raw sugar value, while on September 1st next estimates are that it will approximate to 12,366,000 tons or an all-time high record. The previous biggest was in 1931 with 12,362,000 tons.

DR. WM. L. OWEN.—This consulting bacteriologist has been retained by West Indies Chemicals, Ltd., of Kingston, Jamaica, to supervise their manufacture of materials as acetic acid and acetone from surplus molasses for munitions manufacture in the U.K. His address is P.O. Box 1345, Baton Rouge, La., U.S.A.

SOUTH AFRICAN CROP, 1941.—The crop outlook in Natal this year is reported to be again unsatisfactory, because of deficient summer rains. Until the middle of March they had a record dry summer, but in the following weeks over 6 in. of rain was experienced which removed the immediate danger of drought. At the same time these rains probably came too late to improve very much the growth of the crop. Many factories began grinding early in May. In view of these circumstances, a probable reduction of 10 per cent. in the tonnage of cane reaped this crop is anticipated.

MAURITIUS SUGAR CROPS.—According to the statistician of the Mauritius Department of Agriculture the final figures for the 1940 sugar crop in that island were 316,250 metric tons, as compared with 229,460 tons in 1939, 321,310 tons in 1938, 313,820 tons in 1937, 300,340 tons in 1936 and 280.500 tons in 1935. In 1940 2,762,050 metric tons of cane was ground, the average extraction being 11·45. Of this cane, 54½ per cent. belonged to the factories, about 27 per cent. to Indian planters and 18 per cent. to non-Indians. Of the grades of sugar produced, 87·5 per cent. consisted of raws, 12·2 per cent. of vesous, and 0·3 per cent. of low sugars.

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Notes and Comments.

The Attack on Russia.

Those who were disinclined to believe that Germany's surprise attack on Russia would prove just another walk-over for the hitherto invincible Nazi land forces have been justified in the event, and the critics have been taken by surprise at the strength developed by the Russian resistance. After four weeks of Blitzkrieg tactics, on a vast line stretching from the Arctic to the Black Sea, the Germans have failed as yet to destroy the Russian armies and seize the leading cities and the centres of industry. Their over-optimistic calculations of a campaign lasting a few weeks and yielding them, in the Ukraine, not only great agricultural wealth but also considerable industrial plant and raw material, have been largely nullified by the discovery that the large Russian army is better mechanized and its air force more up-to-date than had been supposed. True, the Germans have made definite headway at most of their spearheads, and the Russians have been all along on the defensive, slowly retreating into their vast country; but at the time of writing the best informed opinion in England seems convinced that the Russian front is still solid in most parts, and no vital break-through seems imminent. At the same time the principal spearhead of Nazi attack which is aimed at Moscow must be causing the Russians considerable anxiety, and it is too early to even hazard how far it will reach and whether it can be halted short of Moscow.

The German attack on Russia had all the elements of surprise in it, as the Russian intelligence from all accounts was not expecting the invasion, if any, for some months yet. Consequently, Russia was not fully mobilized and may only now be developing her full strength. But the German attack, benefitting by that surprise, gained tactical advantages at the start which enabled the invading armies fairly quickly to overrun territory occupied by the Russians to the west of the real Russian borders. Thereafter, the rate of invasion decreased as Russian resistance stiffened, so the actual amount of Soviet territory overrun to date is probably no measure of the actual German hopes. The Russian command has shown so far a degree of strategy and tactics which suggests that the German technique of attack has been much better anticipated by the Soviets than it was by the French last year. There is no Stalin Line to break through ; the defence is clearly one of great depth and mobility, and so far has been supported by ample mechanized equipment and by an Air force which is proving much more efficient than many technical observers had deemed. So equipped, the Russians have been able to launch many effective counter-attacks which have taken heavy toll of the German armies, though doubtless at a heavy cost to the Russians too. But the Soviet forces score in the matter of mere numbers and are defending their own country with a seeming unanimity, unleavened by any quislings in their midst. The extent of their mechanized equipment and of their air force seems to be their own secret and how far it will prove equal in endurance can only be seen in the event. What seems clear, so far, is that the Germans are fighting in terrain which lends itself to the tactics of guerrilla warfare, so the Panzer technique of rushing armoured elements far ahead of the following infantry has not had the success shown in France last year, since Russian forces of varying size have cut in from natural cover and either deprived the mechanical vanguards of their supplies or held up the following infantry. Anyhow, a desperate battle has been, and is being, fought over hundreds of miles and the drain on German fighting power must be very considerable ; and if continued long must seriously affect the German calculations, to put it no worse. The Nazi forces have still to conquer, if they can, the Ukraine, and the Caspian oil wells are yet a long way off. Meanwhile, the Russians have done what it was apparently not politic for the British to do when the latter occupied Greek aerodromes, viz., bomb the Rumanian oil wells and refineries, so the oil problem for the Germans is at least temporarily worsened, in view of the heavy consumption which their mechanized attack on a vast country like Russia must entail.

The British decision to support Russia as another victim of German aggressiveness—irrespective of all considerations of the varying standpoints of democracy and communism — has met with world-wide approval to a degree that was probably not anticipated by the Nazis who must have hoped to weaken American resolution by ideological propaganda. The British response to date has been to intensify the air attacks on Western Germany at night and to invade by air in daylight German-occupied France almost daily, bombing those factories which are obviously turning out material for German use. Incidentally, a well-known engineering works at Lille has been a repeated target in this process. Unfortunately, the nights are too short as yet to enable the night bombers to range further afield than the industrial districts abutting on the Rhine, but in another month or six weeks that drawback should materially lessen and widespread destruction by bomb and incendiary is almost certain to be the lot of the other German industrial centres. Another marked feature of our air force operations has been the success met with in bombing German shipping creeping down the Dutch and Belgian coasts to France. These vessels are seemingly bent on relieving the damaged or congested railways and roads leading to France and the losses suffered by German transport have been, in this way, so considerable of late that if continued long on a similar scale they will raise urgent shipping problems for the Germans themselves, who unlike their enemies cannot draw on American shipping sources for replenishment. It must also seriously affect the problem of transport for the projected invasion of England, probably planned for the early Autumn after Russia had been quickly rendered *hors de combat.*

Other Aspects of the War.

German pre-occupation with Russia has given England several months of relaxation from major bombing raids. But Mr. CHURCHILL has warned the country that it is only a lull and that heavy night raids may be experienced again when the days get shorter. This is only to be expected, but the degree of severity must depend on the extent of the Luftwaffe losses in Russia, though this is not a factor which holds out at present much hope of tipping the balance in our favour. It is to be noted, however, that accounts (from Russian sources) of the first air raids on Moscow suggest that the Russians have developed a good technique for defeating bombing attacks and may take considerable toll of the machines.

The conquest of Syria was not completed without a regrettable loss of men on both sides—men who 18 months ago were assumedly firm allies; but Germany's pre-occupation with Russia was our opportunity and we now hold firmly the Mediterranean littoral right up to the Turkish border, so have blocked an important lane through which the Germans might have attempted to invade Asia and through it Egypt. Turkey is rendered less isolated and can be better succoured in case of attack. Turkey's persistent clinging to neutrality is so obviously dictated by a realization of her mechanical inability to withstand the German fighting technique that no other course seems possible. A factor which has accentuated the defeat of one small country after another at German hands has undoubtedly been the inability, during the last five years, of these countries to secure from foreign manufacturing centres the necessary war material to put up an adequate defence. Those centres have usually been too busy supplying the needs of their own countries. And most of the minor European States have been accustomed to look to Germany and Czechoslovakia for their military eqiupment. This, based on metric measurement, is not quickly replaced by sources accustomed to work by the inch.

With the Syrian campaign over, it may be assumed that the British command in the Middle East is now free to plan if needs be a fresh drive against the Italo-German position in Cyrenaica. So far the Germans have remained dug in around Sollum but it does not appear that they have recently received any further reinforcements ; in fact rumour has it that they have had to deplete their African personnel to go to the aid of the attack on Russia. With more suitable campaigning weather near at hand, the chances are that this quarter will not remain quiescent much longer, since the German front line is too near Egypt to be ignored, other things equal.

The Battle of the Atlantic remains largely unreported, in the interests of naval policy, but now and then we are given a hint that things are improving and that U-boat losses are not inappreciable. But the last total published of shipping losses, though an improvement, suggests that we have still much leeway to make up before we can claim to have overcome the German counter-blockade. Another important stage in American co-operation has been announced in the news that U.S.A. military forces are occupying Iceland and relieving our troops there of the strain of keeping the Germans out. It is assumed that America having gone so far across the Atlantic will be bound to protect that portion of the sea route in her own interests, and the day is envisaged when the British Navy may be left with only the last 800 miles between Iceland and Great Britain to patrol. But the actual plans are necessarily not public and it is probably the case that the U.S. Government is still feeling its way in the matter of this naval co-operation and needs time to get public support for all it would like to do. This would be only in keeping with President Roosevelt's considered policy of winning step by step the support of the vast majority of his countrymen to measures which there is still appreciable reluctance to implement.

The Coming B.W.I. Sugar Crop.

The *West India Committee Circular* states that recently Mr. W. J. Rook, Director of Sugar Supplies at the Ministry of Food, attended a meeting of the Executive of the West India Committee to discuss the sugar situation and to lay before the Committee the Government's proposals in regard to the purchase of next season's West Indian sugar crop. He mentioned that full consideration had been given by the authorities to the special claims which had been advanced on behalf of the several colonies concerned, and he hoped that the consent of the producers in the West Indian area would be forthcoming to the continuance of the present arrangements. Mr. Rook pointed out that the price offered might have been lower than the present one, and that indeed strong representations on behalf of the Colonies had been necessary to avert this. The present low level of world market prices for sugar was of course not an argument which in the nature of things could be a dominant factor in the negotiations, but it was one which appealed to those who, unaware of the many issues involved, regarded the present price (8s. 10½d. per cwt. 96° raws plus 3s. 9d. Imperial Preference)[1] as generous. Thanks to the British and Canadian Governments, the West Indies had an assured outlet for the sugar which they produced, and shipping had been provided with a fair approach to regularity notwithstanding the competing calls which had been made on it. A tribute was paid to the West Indian Sugar Associations, all of whose arrangements had worked with exemplary smoothness, and whose co-operation, shown throughout on points of principle and of detail alike, had been greatly appreciated.

In the course of a very full discussion which took place at this meeting, those producers present showed that they were satisfied that the price offered by the Ministry was the best obtainable in the circumstances. But the speakers showed unanimous concern regarding the cost of production. Economic policy and political policy must go hand-in-hand, and the hope was expressed that the Ministry would continue to keep that vital point before the attention of the Authorities.

While on the subject of the British West Indies we would also quote our contemporary for the statement that it was decided some months ago that a British West Indies Sugar Conference should be convened this summer to meet in Jamaica. Thus the first conference of West Indian Colonial sugar interests ever to be held in the Colonies is arranged to sit during the greatest war in history, which shows that those concerned are exhibiting an exemplary readiness to tackle both contemporary problems and the ones with which the B.W.I. may be faced at the end of the war. The questions under discussion will doubtless be many and varied, and will require careful consideration and treatment in terms not of one colony but of the British West Indies as a whole. And we readily subscribe to the view of our contemporary that all who have the interests of the British West Indian colonies at heart will wish the conference well in the carrying out of its important work. The sugar industry is a vital part of their economic structure and a sound and stable economic life must be the first condition of every form of progressive development in their midst.

An American View of the Sugar Position.

With practically all Europe an armed camp, the dissemination of knowledge with regard to agricultural statistics affecting that continent is naturally reduced to a minimum. Even if the statisticians and the agricultural institutes are able to collect and collate some of their customary data with regard to crops and the marketing of the products, Authority in many cases steps in and forbids publication during the war period for fear that the enemy might benefit from the information. The neutral nation undoubtedly has the best chance of ascertaining what is going on and has not the same objections to publication. At the moment the United States is probably the best clearing house for information as to world sugar matters, though even there they are handicapped by the lack of official information that would in the ordinary course issue from nations which are at the moment belligerent. But, anyhow, it is always interesting in these days to learn what American observers think of the world sugar situation.

Just recently Mr. Ody H. Lamborn, of Lamborn & Co., Inc., the well-known New York sugar brokers, delivered an address on the sugar situation to a Confectioners' Convention at Chicago and endeavoured to answer some questions which are exercising the minds of those who handle sugar in one way or another. What follows is a summary of the chief points he touched on. First comes the question whether after this war we may have a repetition of the price conditions which developed twenty odd years ago, when a temporary serious shortage sky-rocketed sugar prices up to the fantastic figure of 25 cents per lb., to be followed by a frightful debacle when prices plummeted down to 5 cents. The experience of those days "may well be likened to the Florida real estate boom, the stock market boom of the late Twenties and similar cases of wild speculation." In Mr. Lamborn's view, a repetition of that situation is not in the making because the conditions nowadays are radically different.

During the first World War of 1914-18 many beetfields of Europe became the battlefields, sugar factories were targets for shells, and European beet sugar production dropped from around eight million tons to about 2½ millions. Obviously Europe after four years of war was sugar-starved and, with the cessation of hostilities, indulged in a mad scramble

[1] For details see *I.S.J.*, 1940, p. 235.

to obtain supplies from the four corners of the earth. The rest of the world had not immediately the capacity to produce and supply the vacuum quickly. The United States was herself involved in the scramble and found herself competing with the rest of the world, even for Western Hemisphere sugar. The States had to get sugar at one period from such unusual places as Java and Mauritius. There was panic buying, and hoarding was rampant. Today the picture is different; the quick capitulation of France and the Low Countries prevented the substantial destruction of beet fields and sugar factories; even the drastic overrunning of Poland in 1939 probably left the beet sugar areas with no more than temporary damage. So Continental Europe today is to all appearance producing very much of a normal crop, even if inadequate still for normal consumption requirements. Outside Europe, countries like Java, Cuba, and others, temporarily deprived of their European markets, are piling up surpluses that will need some day to find an outlet. As a matter of course world sugar markets are more or less completely dislocated. Nations producing sugar for export cannot dispose of the product in many directions, while many countries ordinarily buyers of cane sugar are unable to obtain it in adequate quantities. Hence arises a situation where stocks are piling up in certain producing countries and other areas are on short rations. During the last war, on the contrary, no surpluses were accumulated. The causes for this present unequal distribution of sugar lie mainly in the British blockade of Europe and the German counter-blockade of Allied countries, which make overseas transport a precarious procedure. A consequence of this inability to market available supplies is shown in the fact that the price of raw sugar has been depressed to a level much below the cost of production. Today raws are selling at approximately 80 cents per 100 lbs. But even before the outbreak of hostilities world prices were depressed, due to the excessive production, the price range from 1934 to 1937 being from 73 cents to \$1·22 per 100 lbs., and this fact led to the formation of the International Sugar Agreement which was making headway in the task of adjusting production to consumption when the present war broke out and put a stop to its operations. So at the present day the world maintains an ample supply of sugar, only too much of it is in the wrong place and must await adequate and reasonably priced transport for its disposal.

Mr. LAMBORN also dealt with the position for sugar in the U.S.A., a market which is necessarily distinct from the world free market. The divorcement of the two came about in 1934 when the Government established a sugar control system which developed into the Sugar Act of 1937. It divided the sugar needs of the United States amongst certain areas, mostly American but including Cuba and the Philippines. Only a negligible portion was allotted to "foreign" sources. Approximately 30 per cent. of the consumption requirements were allocated to the States producers, and 70 per cent. to off-shore ones, and the allocation, as we know, was by quotas which could be raised or lowered as need be. This arrangement of course still rules, and under normal conditions is calculated to meet the consumption needs at a reasonable price. But under wartime conditions, deems Mr. LAMBORN, two factors enter which, if not controlled, may start a spiral of rising prices. One is the question whether shipping facilities will prove adequate for bringing in that 70 per cent. of off-shore production; such facilities are manifestly affected by the "Aid-to-Britain" programme which will cause a considerable drain on available American shipping. The other factor is the danger of fear psychology dominating the American consumer as that country gets increasingly committed to helping the democratic countries, if not to entering the war, and leading to a hoarding programme which might become too great for the suppliers to cope with. Either factor would tend to run up prices beyond that justified by any increased cost of production and distribution. Doubtless the American Government would take the necessary steps to counteract the danger, but the situation might conceivably get out of hand for the time being and necessitate drastic remedies.

As an instance of what can happen, Mr. LAMBORN cites the history of the first four months of this year. During that period, sugar deliveries in the U.S.A. amounted to 2,765,000 tons, as against 1,850,000 tons in the same period of 1940, these deliveries being the largest in history for the first four months of any year in the U.S.A. The public in fact were attempting to purchase and take delivery, in a short space of time, of what they should have taken over a longer period. This was a condition generated by rising freights, by the belief that prices would get higher and, with some, the belief that a shortage of sugar was threatened. Fortunately the buying stopped just short of what could have been an embarrassing situation, for if it had continued for another month at the same rate of intensity, it is conceivable that some of the refiners would have been barren of supplies and forced to close down.

Conditions in Hawaii.

At the last annual meeting of the Hawaiian Sugar Planters' Association — incidentally the sixtieth of the series — Mr. R. A. COOK, the President, commented at some length on the outlook for the local sugar industry. There the results for 1940, although not so bad as those for 1938, have proved again far from satisfactory and it has been a trying year for the whole Hawaiian sugar industry. This has been due, briefly put, to higher costs of production accompanied by lower prices for sugar. The higher costs have been occasioned by increased wages as required

by the Secretary of Agriculture, by taxes which have continued on the upgrade, and by the increased costs of bags, fertilizers and other materials due to wartime conditions, and finally to higher freight rates. Although Mr. Cook does not mention it, it may be assumed that these adverse conditions have had a continuing bad effect on the financial stability of many of the plantation companies.

The low price factor, in Mr. Cook's view, arises from causes that go back several years and rests on the simple fact that under the American quota system there has been more sugar produced than could possibly be sold. In 1936 the average price of raw sugar was just under 3·60 cents per lb. The U.S.A. surplus at the close of that year was 1,490,470 tons. But under the Sugar Act of 1937 the quotas established for 1937 and 1938 were considerably in excess of the sugar consumed in those years in the United States, so that by the beginning of 1939 the surplus had reached 2,112,329 tons. The result of this increase of 600,000 tons in the reserve affected the price of sugar and during the first eight months of 1939 it averaged only 2·85 cents per lb. With the outbreak of war, prices soared for a time and the quota restrictions were suspended for over three months. The effect of this suspension was to augment further the accumulation of reserved sugar supplies within the States, mainland beet and cane, and Puerto Rican cane being the principal areas to be able to take advantage of the opening, though Cuba was able just before the close of 1939 to deliver an additional 350,000 tons of sugar. Hence the quota stocks were some 600,000 tons larger at the beginning of 1940 than was the case a year previously, although the quota arrangements had envisaged a reduction of at least 100,000 tons. On the top of the adverse influence of this surplus, the lack of world demand due to war conditions was a bearish factor, so prices fell again. For the first 11 months of 1940 the New York market price of raws averaged only 2·77 cents per lb., thus establishing a new low record in history. No wonder the outlook for Hawaiian sugar continued black.

When, six years ago, the American sugar quota system was first adopted, Hawaii's annual production was in the neighbourhood of 1,100,000 tons and a further increase was anticipated. But the quota system cut down this figure by 100,000 to 150,000 tons and the plantations had to abandon about 10 per cent. of their cane areas or approximately 24,000 acres, and carry forward cane to succeeding crops. Owing to the two-year crop cycle the full effect of these restrictions did not become apparent till three years later. Then the intentional curtailment was carried even further by two successive years of unusually heavy rainfall. As a result crop areas were thrown out of balance. Furthermore, of late years more new varieties of cane than ever before have proved their superiority by actual field tests, over the varieties formerly used. This results in the quota being filled from less and less acreage, and the difficulties of compliance with quota allowances are being aggravated.

For years, after breeding many hundreds of thousands of new varieties, only one outstanding cane, namely H 109, had been developed. It is therefore surprising that more recently a half dozen or more new canes should appear almost simultaneously. The explanation lies in the use of better breeding stock and the development by the Hawaiian scientists of improved techniques both in breeding and in selection. At any rate, because yields of these new varieties, particularly those of 32-8560 and, for upper unirrigated lands, 2-1063, are so much greater than those ever before obtained, there is eagerness on the part of all Hawaiian plantations to replace existing varieties as rapidly as possible. So despite the abandonment of thousands of acres, the plantations, if the present programme of restriction is continued, will again have far more cane than can be harvested and additional cane areas will have to be abandoned. Still, in Mr. Cook's view, although the enforced reduction of production is an economic waste, it is less so than the waste arising from the production of goods that cannot possibly be utilized.

He however deems that means of utilizing so vital a product as sugar should be found, even though Governmental subsidy may be necessary to accomplish this purpose. With this end in view the H.S.P.A. have entered into an agreement with the Mellon Institute whereby that organization will resume the research work, which it commenced but soon abandoned some years ago, to find other uses for sugar. But spectacular results are very unlikely; even if they are obtained considerable time must be devoted to research and to the practical application of the findings. Meantime Mr. Cook thinks that restrictions should be removed which prevent the use of sugar and molasses for making alcohol. Geologists may differ as to the duration of the world's visible supply of petroleum, but some of them think it a matter of not more than 40 or 50 years, even allowing for newly found oilfields. If all the fermentable crops at present grown in the U.S.A. were converted into motor fuel, it would not exceed half the present gasoline consumption there. There is therefore vast scope for the agricultural production of materials for making alcohol but the current price of the oil remains too low to allow the economic production of sugar cane and sugar beets for alcohol, unless government support is forthcoming. If the U.S. Government can provide billions of dollars to furnish irrigation to millions of acres of new land and other billions to undertake soil conservation, it is argued that they might equally well give financial support to an agricultural scheme for conserving at least some of the invaluable petroleum resources, and thereby reverse the present serious tendency of reducing both cane and beet acreage.

Climate and the Sugar Cane.

Of the dry matter of the plant, the overwhelming part is derived from the air and the residuum only from the soil and it is, therefore, somewhat surprising, when one comes to think of it, that a disproportionate effort is expended on the effects of different soil conditions, particularly in the matter of available plant food. This appears to be due to the emphasis laid on the crop cycle and yields as determined by variables imposed within the single season. Yet climatic variations of no mean order occur from year to year and produce reactions on the plant which may be out of all proportion to those resulting from soil differences. It is of interest, therefore, to try and trace both those reactions to climate and the *modus operandi* of the factors at work. In many cases, particularly in continental tracts, this involves observation over a series of years and a good deal of luck, for it may be several years before sufficiently contrasting seasons are met with. The case is different in the island cane growing areas, especially those with a mountainous topography, for very different climatic conditions may often be found at very short distances. The Hawaiian islands are peculiarly well situated in this respect; advantage has been taken of this fact by H. F. Clements and his conclusions are given in a paper entitled "Integration of Climatic and Physiologic Factors with Reference to the Production of Sugar Cane."[1]

The work described refers to cane at Waipio and Kailua, both situated on Oahu and only a few miles from each other. At the former place the rainfall is so scant that irrigation is practised, some 100 in. of water being supplied per annum, while the days are very bright and warm; at the latter the rainfall is adequate with an apparently cooler day. Actually there is little difference in temperature, the real difference being in light intensity. The yields obtained from quarter acre plots of the variety 31-1389 at the two stations showed a very large difference; 134 tons cane per acre with quality ratio 7·2 and sucrose per acre 18·6 tons at Waipio, and 65 tons cane per acre with quality ratio 9·0 and sucrose per acre 7·2 tons per acre at Kailua.

The first step in tracing the cause for this large difference is to evaluate the soil effect and, for this purpose, pot cultures in soil from the two stations were grown under Waipio conditions. After four months the small and insignificant difference in growth was, if anything, in favour of the Kailua soil. In the field the only difference in fertilizer lay in the nitrogen application, 225 lbs. N at Waipio and 150 lbs. at Kailua. Relative to plant growth, the application at Kailua is the heavier while leaf analyses indicated that the nitrogen level in the plant was higher at this station than at Waipio.

Since soil differences were inadequate to explain the large divergence in yield, the causes had to be sought elsewhere. The major climatic difference lay, as has been said, in moisture and light intensity. Moisture was largely eliminated by irrigation and could hardly have a controlling effect, and this left light intensity, a measure for which remained to be found. A measure partially indicating this is the "day degrees" devised by Das who used this measure and found a close correlation between the accumulated "day degrees" and crop yield. The "day degree," being the number of degrees excess of the maximum reading for the day above 70°F., is clearly not a full measure of the light intensity for, in cloudy weather, the temperature curve is very irregular. Actually the accumulated day-by-day totals of "day degrees" at Waipio and Kailua respectively were 9374 and 5693. This is clearly not a full measure of the yield difference for, with 134 tons at the former station, the latter station should have yielded some 81 tons. Another measure had to be found and it was found in what are termed "sunlight degrees." This measure is based on thermograph readings of a white bulb within a standard weather kiosk and of a black bulb exposed outside. In both cases planimeter measurements are then taken of the area above 50°F. for the daily period, 6 a.m. and 6 p.m., and these are divided by the area of 1°F. for a 12-hour period and the dividend added to the 50°F. base. The difference between the values so calculated for the two bulbs is taken as a measure of light intensity, and cumulative values, as in the case of "day degrees," can be used. In cloudy weather the maximum reading necessarily exaggerates the evaluation of the "day degrees" reading, leading to a high ratio between "day degrees" and "sunlight degrees."

Having determined the method of measuring the light intensity, it remained to find a measure of growth. The various possibilities considered cannot be given in detail here; ultimately final selection fell on three factors, length increase of the stem measured monthly—a measure which was found to be in close agreement with the measure based on green and dry weights,—leaf area calculated from area of the individual leaf multiplied by number of leaves, and density measured as number of stalks per linear foot of row. This last was only taken into consideration after the sixth month when the crop had closed in.

In a comparison of the leaf areas at the two stations, that for Waipio showed a gradual increase up to a maximum of 11,049 ccm. per plant at 11 months and an equally gradual fall subsequently to 4778 ccm. at 21 months. At Kailua there is no such regularity, the figure reaching a maximum of 7557 ccm. at nine months and remaining substantially

[1] *Hawaiian Planters' Record*, **44** (1940), p. 201.

constant till the 16th month when a more gradual fall takes place with the result that, at 21 months, the figure for Kailua is 5426 ccm. against 4778 ccm. for Waipio. The relative density at the two stations remains at unity for the first six months when a gradual fall takes place till, at some 12 months, that of Kailua becomes stabilized at approximately 0·80 of the Waipio figure.

An attempt is now made to calculate the growth increment for Kailua from the Waipio figure, using the above factors. The formula adopted is

$$G_K = \frac{G_W \times A \times L}{D}$$

where G_K and G_W are the growth increments at Kailua and Waipio respectively, A is the ratio of leaf areas at these two stations, L the corresponding ratio of light intensities and D the corresponding ratio of the densities. The figures for G_W and G_K are both tabulated and plotted and the agreement of the calculated with the found values is very close indeed, though the coefficient of correlation is not given. Other climatic factors necessarily enter into any general consideration of climate and plant relationships, temperature, particularly in its seasonal range, and length of daylight. In these particulars, however, the climate of Hawaii is very uniform leaving the intensity of sunlight as the dominant factor.

Though sunlight is shown, thus, to be the dominating factor, it does not follow that the fertilizer requirements are unimportant. Within the limit set by this uncontrollable natural condition of growth, fertilizers can, and do have a material effect if the three plant-food elements tend to act as limiting factors. The economic aspect here comes into prominence. Estimates of fertilizer requirements based on field experiments are valid only for the particular area and particular season and to apply fertilizers based on trials at Waipio, for instance, to the crop at Kailua would entail waste for, with the lower limit of growth at the latter place, the requirement would be smaller. What is desired, therefore, is some ready method by which the plant can be followed throughout its growth in the actual field. This desirability applies particularly to nitrogen which is held in the soil in a relatively unstable condition. The aim is to find an index of the plant's general state of well-being indicating its reaction to the weather.

This part of the investigation consisted of comparisons of the composition of corresponding parts of the plant at the two stations at monthly intervals. Subdivision of the plant was very detailed; stem from base in sections of three internodes; leaves No. 7 from top to lowest divided into blades and sheaths and the corresponding stalk section, leaves 3 to 6 similarly divided, with stalk; leaves 1 and 2, with the meristematic tissue, divided into two, a lower 5 in. and the remainder. Details of potash and phosphorus content are given only for leaves 3 to 6 which, being the most active part of the plant, are likely to give the best index.

With regard to phosphorus, the level at Waipio at an average of 0·301 per cent. dry weight is higher than at Kailua at 0·245 per cent. but various cogent reasons are given for believing that this lower value is no indication of deficiency; at Waipio this element appears to be in excess. With regard to potash the relative figures are 1·54 and 1·89 per cent. of dry weight and again evidence is produced to justify the belief that, in both cases, potash is being taken up in excess of requirements.

The nitrogen analysis is much more intricate owing to the differential distribution within the plant and is given in detail. The meristem is richest (over 2·5 per cent. dry weight) followed by the elongating blades and stalk (over 1·0 per cent.). Comparatively there is little difference in any part of the green portion but below, at Waipio, the nitrogen content falls from 0·26 per cent. in the top internodes to 0·14 per cent. in the lowest while at Kailua the content remains practically constant at between 0·51 and 0·36 per cent. From consideration of the detailed figures it is concluded that the best index for nitrogen is given by the percentage composition (dry weight) of the young leaf blades.

The industry, however, is not concerned only with weight of cane, the sucrose content is of great importance. An equally detailed analysis of the total sugars, corresponding to the nitrogen analysis, has been made and given, and the total sugar content in the young leaf sheaths is taken as index, which will rise with sub-normal, and fall with super-normal growth. For the first 16 months of the crop season (under the Hawaiian conditions of the actual experiment) it is desired to keep carbohydrate formation and consumption balanced and, from the present record, the above index is found to be near 10 per cent. After that period it should rise to some 15 per cent. Any considerable rise or fall above this figure indicates some maladjustment the cause of which must be sought in the other indices, in the present case sunlight intensity index, nitrogen index and moisture index (dry weight of young leaf sheaths as percentage of green weight), for potash and phosphorus are here adequate throughout growth; but, so long as the total sugar index ranges around 10 per cent., maximum growth under the conditions is being obtained. The major practical control is water supply which indirectly affects nitrogen absorption, a control which is applied during the season of growth. It would seem possible also to adapt the nitrogen supply to the greater or less expected demand.

H. M. L.

JAMAICA'S 1941 SUGAR CROP.—The West India Committee *Circular* states that the latest crop estimate for Jamaica is 154,250 tons, which is likely to be attained, as the crop is well advanced. Earlier estimates were about 5,000 tons less.

Experiences with Sugar Cane in South Africa.

Fifteenth Annual Congress, South African Sugar Technologists' Association, 1941.

The season which must have been fresh in the minds of those who attended the recent Congress of the South African Sugar Technologists' Association was, in many ways, an exceptional one and recorded, with the exception of 1934, when the crop was stricken by locusts, a fall in the production of sugar for the first time since 1931. Some measure of these exceptional conditions is given in the Reports from the Chemical Laboratories, a summary of which was presented to the Congress by H. H. DODDS and J. L. DU TOIT. The main disturbing feature was the weather, particularly the rainfall. During the first three months of 1940, a vitally important period for crop growth, rainfall in January was very deficient except in Zululand, deficient throughout in February and very deficient in March except for heavy rains north of Gingindhlovu (Lat. 29°). April gave no relief and, by the end of the month, there was, over most of the area, a deficiency of over 55 per cent. Heavy rainfall in May saved the situation but, at this season, owing to low temperatures, the response in growth was small while the ripening process was delayed. If these conditions caused concern, as they must have done, to the industry as a whole, they have not been without value to the technical staffs, for experience of limiting conditions offers valuable lessons, indications of which appear in the Summary.

As might be expected, the normal crop, whether of one or two year cane, was not only small but of poor quality. That the actual weight of cane harvested was not smaller was due to the amount of surplus, three or four year cane. The sucrose content of the cane for the season was 13·18 per cent., excluding the locust ridden year the lowest since 1929; the recovery was 10·27 per cent. of sugar on weight of cane. Season and old canes account for these indifferent figures. The analysis of these figures brings out some interesting points. Manufacture was unduly prolonged, being extended into February. Nearly 18 per cent. of the sugar was produced during the two months May and June when the sucrose content was as low as 12·18 and 12·27 per cent. respectively while nearly 10 per cent. was produced in December and onwards when the sucrose content for the three months December, January and February was 12·56, 11·91 and 11·61 per cent. respectively. The peak month for sugar content shifted from the usual September to October and was 14·11 per cent. Fibre content was, too, unusually high, averaging 15·56 and it showed unusual features. In place of the well-marked minimum content about September, a steady rise from 15·13 per cent. in May to 16·47 per cent. in January took place. How far this is a peculiarity of the particular season is not clear for the explanation is complicated by the varying proportions of the different varieties which went to make up the crop harvested as the season progressed. Thus the high fibred variety Co 281 from forming 24 per cent. of the June harvested cane, rose to 48·6 per cent. for February, while the low fibred Co 290 fell from 38 to 20 per cent. during the same period. Cutting across these, Uba fell from 31 to 14 per cent. and POJ 2725 rose from 2 to 16 per cent. The proportion of the total crop contributed by these varieties was: Uba 23·2 per cent., Co 281 37·5 per cent., Co 290 28·1 per cent. and POJ 2725 7·9 per cent. Purity of juice, though low for the season at 85·34, reached its peak of 86·56 at the usual time (October) but fell to 83·00 in January, one of the lowest figures ever recorded in South Africa. The reducing sugar ratio was, at 3·81, abnormally high with a minimum of 3·13 in October, rising to 4·61 in January and 4·94 in May.

These are the main characteristics as induced by the vagaries of the season. Nevertheless the factory performance was well maintained at 91·90 per cent. recovery, a figure only surpassed in the season 1939/40 with cane of much superior quality. A very detailed return of the 21 factories is included in the Summary, the remainder of which is devoted to a discussion of the position of the South African industry in relation to the world's sugar crop. From this it appears that South Africa produces 1·83 per cent. of the world's sugar or 3·00 per cent. of the world's production from cane and 8·77 per cent. of the British Empire production. A statement of the annual production of South Africa shows an almost uninterrupted rise from some 12,000 tons in 1891/92 to 572,880 tons in 1940/41, the latter figure being surpassed only by the production of 1939/40 with 595,556 tons.

The weather conditions, briefly outlined above, are given in much detail in a supplement to this paper.

SUGAR CANE VARIETIES.

Reference has been made above to the complications introduced by the varietal position in tracing the effect of the abnormal weather conditions in the crop figures. The varietal question is, in fact, playing a large role in the evolution of the industry with each year that passes and a summary of the present position was communicated to the Congress by H. H. DODDS. This forms a progress report supplementing the earlier account contributed to the 1938 Congress.[1] In the intervening period no new varieties have been released but considerable progress has been made in the replacement of Uba by the four released varieties, Co 281, Co 290, Co 301 and POJ 2725, the last of which, however, has a small proportion of POJ 2878 classed with it. Since 1935 Uba has shrunk from 70 per cent. of the total crop to 23 per cent.; in the last three years the proportion of Co 281 has risen from 21 per cent. to 37·5 per cent.; Co 290, at 35 per cent. the most

[1] *I.S.J.*, 1938, p. 336.

widely cultivated cane three years ago, has shrunk to to 28 per cent. while Co 301 has increased to 3·3 per cent. and POJ 2725 has shrunk from 11·3 to 7·9 per cent. Moreover these figures are not a true representation of the position since the area under Uba consists mainly of old ratoons, while figures for the newly planted area in April, 1939, show only 3 per cent. of the 95,000 acres was under Uba and, south of Durban, only 139 of the 20,000 acres. While the yield of Uba has remained remarkably constant at about 20 tons per acre, that of the new varieties has shown a steady increase, amounting to 31·57 tons in 1938, indicating a growing understanding of the requirements of these.

South Africa, thus, is rapidly coming into line with most other cane growing countries in that an increasing reliance is being placed on a range of varieties and, as is the general experience, the adaptability of these to the different conditions is a matter of growing importance. This aspect is now under examination and a number of experiments are quoted in illustration. Co 281 and Co 301 have proved the more adaptable, while POJ 2725 is best adapted to the alluvial soils. Co 281 is well adapted to stiff and heavy soils and ratoons well. Over five crops (plant and four ratoons) its average yield has been 38·32 tons (5·78 tons sugar) against 28·32 tons (3·99 tons sugar) for Uba and 29·22 tons (3·92 tons sugar) for Co 213. It is not only drought and cold resistant but disease resistant, no field case of either mosaic or streak having been recorded. Co 290 is less hardy, and adapted to sandy, well drained soils. Under conditions such as these it has averaged, over five crops, 27·93 tons with the record average sugar content of 15·18 per cent. It is slightly susceptible to streak disease but the main reason for its set-back in recent years has been its inability to hold over long after it matures. Co 301 is a comparatively new introduction to general cultivation but is rapidly gaining favour. It has yet to be fully tested for drought resistance, especially on heavier soils. Premature arrowing and a liability to break in heavy rains and wind are its main disadvantages.

Although no new varieties have been released since 1935, when Co 301 came into commercial cultivation, a large number of varieties has been introduced. The two most promising of these are Co 453, a cross between Black Cheribon and Co 285, and FC 916, a cross between POJ 2725 and SC 12/4. Of unreleased varieties introduced before 1938, Co 331, Co 421, Co 426, Co 432, MP 28 and PR 809 are the most promising, particularly Co 331. It is, however, late maturing and, though out-yielding Co 281 by three tons per acre at 14 months in trials, it gave less sugar owing to its lower sucrose content. At 21 and 24 months the difference was not so great, in fact, at the later stage, a small though insignificant increase in sugar was obtained. It is pointed out that, while improvement upon Uba was a relatively simple matter, the higher standard set by the first introductions makes successive stages harder.

In addition to varietal introductions, fuzz has been imported since 1936 from various stations, notably Coimbatore, Mauritius and Hawaii. None of the seedlings raised from this fuzz have yet been released though the most forward have reached the stage of replicated field trials and some are promising especially in the direction of high sucrose content.

Bud Sports.

In efforts to secure new varieties of economic plants the most usual procedure is to cross two varieties and by this means, secure a wide range of types from among which it is hoped to select one or more possessing characters which make it superior to either of the parent plants. If that plant, like the sugar cane, is capable of vegetative propagation, the breeder's work is done, for it is unnecessary to secure sexual purity as is the case with a plant propagated from seed. As with most natural phenomena, however, exceptions occur and even among vegetatively propagated material variation may occur. In the case of the sugar cane such variation has been long known, though with a frequency insufficient to invalidate the general proposition that vegetative propagation offers a short cut to the rapid extension of a variety. Of this "sporting" habit it is the common experience that it is the same character which from time to time appears; more rarely does the whole appearance of the plant change. Frequently it is merely a question of colour change as with the striped and black forms of Cheribon and Tanna canes. The list of such vegetative mutations or sports in sugar cane is added to by A. McMartin who notes cases observed in Natal. One such is of a striped form of Uba, sufficiently common to be frequently seen in fields of that cane. A further case, also in Uba, is a plant of different habit which, though lacking the stripes, there is reason to suppose has arisen from the striped form. In Co 281 as well as in the other released varieties, a number of variant forms have been observed and briefly described.

These are differences capable of optical determination. Some years ago the suggestion was made (probably in Hawaii, but the reference has proved elusive) that similar sporting might occur in those characters which are of such economic importance in the cane plant but which are not optically determinable. The same point is raised here but efforts to trace the resistance to streak of single healthy stools in heavily infected crops of Uba to such a cause have proved abortive.

Finally, the legal conundrum is propounded as to the position of the cane farmer who, growing one released variety, finds it throwing off "sports." Forming as they do technically another variety, their growth is, technically, illegal

H. M. L.

Experimental Field Work in Puerto Rico.[1]

Puerto Rico is an island with a very diversified agriculture and its agricultural institutions are, therefore, concerned not with one crop only. The following information is gleaned from those sections of the Report which concern themselves with the sugar cane, the principal cash crop of the island.

The Station possesses one of the largest variety collections in Central and South America and has received the addition of POJ 2961, B 3013, CP 28-19, M 275 and M 317. In all, the number of varieties totals over 400. A local seedling, B-2-5, now raised to the status of PR 900, is showing much promise in field tests though it has not yet been released for commercial planting. Its outstanding characters are high sugar yield, vigorous growth, no arrowing, and immunity to mosaic and gumming. Other seedlings not so thoroughly tested as to justify insertion in the PR series are C-1-146 and C-1-69. The latter possesses a slight superiority over other seedlings in growth habit and appears to be resistant to excessive soil moisture.

Fertilizer trials on Coloso silty clay showed a response to nitrogen and potash but not to phosphorus. The main interest in these results lies in the comparative Mitscherlich pot tests using Hegari Sorghum as an indicator. The pot tests showed a response to phosphorus not reproduced in the field trials with sugar cane, and it would appear, therefore, that Sorghum is not a satisfactory indicator plant of the deficiencies of a sugar cane soil. Other cases are quoted with a like failure of accord between field and pot experiments, using respectively sugar cane and Sorghum, when potash has been the subject of comparison. A good correspondence has, however, been obtained when certain other plants (Sudan grass, potatoes and sundry vegetables) took the place of sugar cane.

Experiments on Vega silty clay with dressings of 150 lbs. NH_3, 50 lbs. P_2O_5 and 120 lbs. K_2O per acre applied in one or two doses showed no appreciable differences and the recommendation follows, to save the extra cost of the double dressing, that a single early dressing be made. A similar experiment on Coto clay gave a like result.

An experiment started in 1934 to test the residual effect of nitrogenous fertilizers both on crop yield and on soil reaction was continued. The dressings were 150 lbs. NH_3 per acre, 80 lbs. P_2O_5 and 100 lbs. K_2O with nitrogen supplied alternatively as calcium cyanamide, sulphate of ammonia and sodium nitrate. So far, no statistically significant differences have been found either in yield or *pH* values. Ploughing under crops of *Crotolaria striata*, too, has led to no significant gain in yield either in plant crops or ratoons. In the matter of irrigation, weekly applications of 1 in. and 1·5 in. of water produced the best results and the former application is, therefore, recommended as being the most economical.

In Louisiana considerable store has been set on *Trichogramma* as a control of the moth borer *Diatraea saccharalis* and it is not unnatural to find that the life history of that parasite has there been investigated in considerable detail. The conclusion drawn is that temperature is the factor of most importance in influencing the percentage of parasitism. Oviposition there rapidly increases as spring advances and early release of artificially reared parasites becomes advantageous. In Puerto Rico conditions are very different; there is little variation in temperature while the seasonal rainfall shows great differences. Earlier investigations showed an apparent correlation between rainfall, abundance of *Diatraea* egg clusters and parasitism by *Trichogramma*, but later investigations indicate that this correlation is spurious, and, in many cases, no correlation has been found to exist between season, rainfall and parasitism. This is the conclusion derived from systematic investigations carried out in a large number of localities. Experimental releases indicate that artificial releases may result in largely increased parasitism but, until proper timing can be determined with reasonable certainty, systematic release on a commercial basis remains impracticable. Without any dominant factor on which to base control, the less readily determined factors classed as 'microclimate' assume major importance. Meanwhile a new egg parasite of *Diatraea* has made its appearance in *Prophanurus alecto*. First observed in Guanica, it has since been found in several other localities. Parasitism by it was generally low but in one field at Guanica it reached a figure of 87 per cent.

Among other work of more general interest of which an account is given, is that which indicates the main differences between the soils of the humid and the arid regions. As the result of over 300 analyses, it has been found that the soils of the humid area have an average *pH* of 6·1, whereas those of the arid area average 7·7, making the former some 40 times more acid. The average organic matter of the humid area is about double that of the arid but the total nitrogen is approximately the same. Phosphoric acid (available) in the humid area is about half that in the arid (0·008 to 0·017 per cent.) and the same is the case with lime (0·31 to 0·68 per cent.), while the average potash is about 13 per cent. less (0·020 to 0·023 per cent. As a corollary to these, it has been found that many of the soils of the humid regions require dressings of lime for maximum production. Of available nutrients the main deficiency lies in nitogen.

H. M. L.

1 Annual Report, University of Puerto Rico, Agricultural Experiment Station, 1938-39.

Unsolved Problems of Agricultural Chemistry.[1]

By Dr. C. A. BROWNE.

For the purpose of this discussion agricultural chemistry is defined as that branch of chemistry which treats of the chemical composition and mutual chemical relationships of soils, fertilizers, crops and farm animals. The industrial utilization of agricultural produce beyond the frontiers of the farm falls outside the scope of this definition. Among the agricultural chemical problems requiring more intensive investigation the following are mentioned :—

Chemical Analysis.—Since the time of LAVOISIER progress in agricultural chemistry has advanced in strict proportion to improvements in the art of chemical analysis. This is especially demonstrated in the present era when the application of more refined chemical, physical and biological methods of analysis has established the recognition of the importance of minute traces of hitherto neglected mineral elements and of the almost intangible organic agencies such as vitamins, enzymes, auxines, viruses and hormones. It may be asserted with confidence that future progress in agricultural chemistry will depend upon effecting still greater improvements and refinements in analytical methods of research.

Aqueous Fluids in Crop Tissues.—In the analysis of the sugar cane, sorghum and other crops, conventional estimates are made of the composition of the so-called "normal" or total juice, whereas actually there occur in each plant not one but many saps or juices—as those of the vacuoles, the cytoplasm, the ducts, nectaries and other organs, each with its own peculiar composition. The micro-analyst, by investigating the composition of each of these cellular juices, will help greatly towards solving a number of important neglected problems that relate to the chemistry of crops and to the best methods for their utilization.

Environmental Influence.—More investigations are needed to evaluate the respective influences of soils, fertilizers, cultivation, rainfall, temperature, altitude, sunshine and other environmental factors on the yield and composition of crops. Variations in yield and composition have been attributed to differences in soil and fertilizer, when the determining factor was climate. The best method of ascertaining the degree of climatic influences is by means of soil-exchange experiments. It has been found, for example, that wheat grown on a Maryland soil in Kansas contained 6 per cent. more protein than the same variety of wheat when grown on the same soil in Maryland. The predominance of climate over soil has also been demonstrated by soil-exchange experiments with sugar cane in the Hawaiian Islands.

Distribution of Mineral Elements.—It is a strange anomaly that, in their study of the human, animal, plant, and mineral worlds, chemists have usually selected problems in the inverse order of their immediate concern. The relative abundance of some fifty elements in the rocky crust of the earth has been carefully tabulated upon the basis of thousands of analyses while only rough compilations have been made of the abundance of some 20 or 30 elements in the average soil. In the case of plants the obsolete tabulations of WOLFF, which are still the most complete that are available, give the abundance of only nine of the common mineral elements occurring in crops.

As for the composition of the mineral matter of animals and man, only a few very rough tabulations of the more important elements are available, exact information on the relative abundance and distribution of the minor constituents being almost wholly lacking. The filling of these gaps in our knowledge and the extension of such information to a study of the mutual relationships of the mineral elements of soils to those of crops and animals under different environmental conditions belong to some of the major unsolved problems of agricultural chemistry.

Improving Nutritive Values.—Proposals have been made to increase the content of nutritive mineral elements in crops by special methods of intensive fertilization. The mineral content of crops can be modified within certain limits in several ways. Different varieties of grains and vegetables vary in their capacity for assimilating different elements from the soil.

The production of crops with a preponderance of certain mineral nutrients might be advantageous for certain requirements provided there was not a corresponding diminution of some other essential nutrients, as frequently happens. Caution must be exercised in the employment of patented mineralization formulas for so many factors influence the composition and nutritive value of crops that a special scheme of fertilization adapted to one locality might be highly detrimental in another situation.

Deterioration of Products.—The losses from the deterioration of raw and manufactured agricultural products during storage and transportation amount each year to a sum of colossal proportions. The role of micro-organisms, enzymes and atmospheric influences has been extensively studied in this connexion, but a fourth highly important agent of deterioration, viz., the undesirable chemical changes which take place within the product itself, has been generally overlooked. Examples of such internal chemical changes are the darkening of syrups, honey and other food products as a result of slow combinations between sugars and amino acids (the so-called Maillard

[1] *Chronica Botanica*, 1940, 6, p. 1.

reaction). Haystacks catch fire spontaneously and tanks of sugar cane molasses sometimes undergo spontaneous heating and carbonization as a result of obscure chemical reactions that take place within the product itself. The nature of these spontaneous chemical changes in our agricultural products constitutes a very important unsolved problem.

Economic Problems. — Economic problems of national importance frequently arise and to many of these agricultural chemists are the only ones qualified to give a decisive answer. Politicians in America and other countries have debated the question "Is the sugar beet an economic crop?" Judged alone by the comparative costs of producing beet sugar in temperate zones and cane sugar in the tropics, the sugar beet appears to be a very uneconomic crop, but when the great improvement of the surface soil produced by growing a deep rooted rotation crop, such as the sugar beet, is considered, together with the greater productive power which the beet gives to the soil for succeeding crops and the great stock-feeding value of the beet leaves, pulp and molasses, the balance of chemical evidence is that the sugar beet is a very economic crop wherever it can be successfully grown. The indirect economic benefit or injury of farm practices is too often overlooked. It is a subject to which agricultural chemists should give greater consideration.

Notes on Milling and Milling Practice.[1]

By L. S. BIRKETT, A.I.C.T.A., A.M.Inst.B.E.

One of the results of studies of the milling process has been to lay stress on the importance of local conditions, which are undoubtedly important. It is felt however that there is scope here for the investigation of a wide range of milling practice and conditions. It is therefore the object of this paper to describe some of the results of a study of data collected from various countries, in the hope that this may be of general value to mill engineers and chemists.

Capacity.

The work of a milling plant may be viewed and judged from two aspects, namely, Capacity and Efficiency. These are closely inter-related.

The Capacity of any mill tandem may be varied within very wide limits. There will, however, be a certain rate which is normal for any particular size and type of equipment. In a previous study,[2] a formula was derived for measuring the normal capacity of any given size and type of milling equipment, the capacity being stated in terms of long tons of fibre passed per hour.

Rating Index.—In order that capacities may be referred to a basis suitable for comparison, a rating index is used. It is obtained by expressing the actual capacity of a tandem as a percentage of its normal capacity as measured by the capacity formula previously stated. As may be expected, differences in local conditions necessitate differences in the rating at which individual mills are operated. The rating index, however, serves to measure the degree of divergence from normal capacity at which any particular mill is being operated. The value of this measure when judging mill efficiency will be demonstrated later.

Efficiency.

The efficiency of a tandem is best measured by the absolute juice lost per cent. fibre. The simplest method of judging the work of a tandem is by the use of indices which refer to average or normal work as a basis. The use of a rating index for comparing capacities has already been noted. The use of an efficiency index, and of an overall mill performance index, will be described below

All of the numerous variables in mill work have an influence on the efficiency attained. However, the four major factors in this connexion are: the imbibition per cent. fibre, the rating at which the tandem is operated, the physical characteristics of the cane fibre, and the pressure applied at the mills. Comments on these are necessary.

(1) *Imbibition per cent. Fibre.*—This factor is subject to very wide variation in mill practice. At normal rating and at any given imbibition per cent. fibre, a certain amount of absolute juice lost per cent. fibre is normal. The relationship between imbibition per cent. fibre and absolute juice lost per cent. fibre has been given previously,[3] and is here reproduced and extended to cover a wider range of milling equipment (Fig 1).

Efficiency Index.—This index is introduced in order to measure the efficiency of any given tandem, by comparing the figure for the absolute juice lost per cent. fibre for that tandem with the normal loss (as shown by Fig. 1) at the same imbibition per cent. fibre as actually used.

For example, suppose that a 14-roller tandem is operating at normal rating and an imbibition per cent. fibre of 200, and that the absolute juice lost per cent.

[1] Read before the Technical Committee of the Berbice Sub-Committee of the British Guiana Sugar Producers' Association.
[2] *I.S.J.*, 1936, pp. 416-419. [3] *Loc. cit.*

fibre was 28·8 per cent.; referring to Fig. 1, it is seen that the absolute juice lost per cent. fibre to be expected as normal at this imbibition is 28·0 per cent. The efficiency index is therefore : 28·0 × 100 / 28·8 = 97·3.

(2) *Rating.*—Rating is also subject to wide variation and its effect on efficiency is measurable. In general, a given percentage increase in rating will usually be accompanied by a corresponding decrease in the efficiency index and vice versa. This statement is true at ± 30 per cent. differences from the normal rating. Outside of these limits the correlation is not high, but the percentage of mills operating outside of these limits is small.

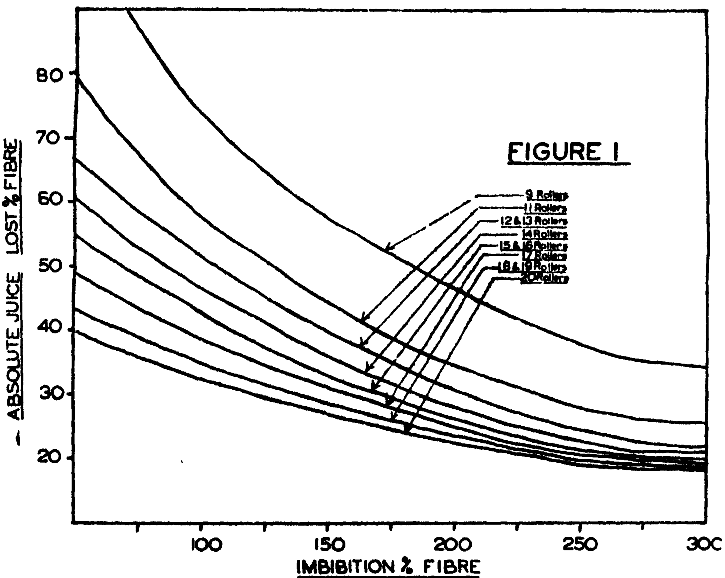


Fig. 1.

A typical example is that of a 14-roller tandem operating at a rating of 120 and with an imbibition per cent. fibre of 200, the lost juice per cent. fibre being 35·6. The efficiency in this case is : 28·0 × 100 / 35·6 = 78·7. That is to say, at 20 per cent. above normal rating there was approximately 20 per cent. fall in efficiency below normal (in this case actually 21·3 per cent.).

Overall Performance Index.—This index serves to measure the work of a tandem as a whole. It is obtained by adding the rating index to the efficiency index and dividing by 2. In the example given above, the overall mill performance index is : 120 + 78·7 / 2 = 99·4.

If the work of the tandem is normal with regard to the relationship between capacity and efficiency, this index will be 100. Better work than normal will give an index in excess of 100; conversely, work below normal is shown by an index under 100.

(3) *Physical Characteristics of Fibre*—The milling of "hard" canes such as Uba and Co 290 and 281, presents special difficulties, as the fibres of these varieties are very resistant to crushing. In the case of "soft" canes, it will usually be found that as the fibre content of the cane rises, so does the water content of the bagasse fall.

Such is not the case with the high fibred hard canes, and it is possible that much of the high moisture content and lost juice in the bagasse from these varieties may be due to a relatively large percentage of unruptured cells in the bagasse, or to cells which have only been ruptured late in the milling process. If this view is correct, then the logical procedure when milling these varieties would be to ensure thorough preparation of the cane by knives and shredders prior to crushing.

The writer has frequently noticed that during a drought soft cane varieties, such as BH 10/12 and POJ 2878, develop fibre properties approximating those of the hard varieties. This is attributed to the larger percentage of nodes in the shorter canes which result under conditions of drought. In such cases less fibre is passed with normal settings, more power is consumed in milling, and the water content and lost juice in the bagasse is increased.

The curves given in Fig. 1 were obtained from data collected on a previous occasion.[1] The bulk of these data necessarily applied to the milling of soft cane varieties, since these form the major proportion of the canes milled. Consequently, the data given in Fig. 1 are not applicable where hard cane varieties form a high percentage of the cane milled. In cases where only hard cane varieties are milled, the absolute juice lost per cent. fibre to be expected at any given imbibition per cent. fibre will, at normal rating, be approximately 35 per cent. greater than that given in Fig. 1.

(4) *Pressure Applied at Mills.*—The extraction of juice from cane or bagasse is chiefly dependent upon the amount of pressure applied for crushing. In practice, however, this factor appears to be less important than are rating and imbibition per cent. fibre. This is mainly due to two reasons :—

Firstly, variations in pressure from the mean value are usually comparatively small in most instances, while those in rating and imbibition are often considerable in individual tandems.

Secondly, the use of both imbibition and pressure is subject to the law of diminishing returns. In the case of the former, the quantities now in use are

[1] *Loc. cit.*

generally within the range where increasing quantities give appreciable increments in yield of juice. This is illustrated graphically in Fig. 2.

From the point of view of the effect of pressure on the overall mill performance index, it appears unlikely that further increase in pressures will produce any appreciable increase in the index. This is due to the reasons given above, coupled with the fact that any appreciable increase in pressure above average will tend to reduce the rating. However, there is need for investigations dealing with the effect of increasing pressure.

After this preliminary review, it will be of interest to survey very briefly milling practice and performance in various cane-growing countries.

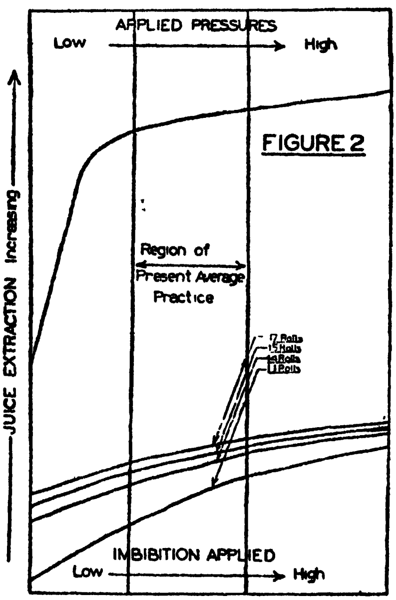


Fig. 2.

MILLING PRACTICE.

(1) *British Guiana and British West Indies.*[1]—The majority of the tandems in this area consist of 11 and 14-roller combinations. Where heavy tonnages of cane are ground, two tandems have generally been installed. The majority of the tandems in the Islands are preceded by cane knives, but their use is not usual in British Guiana. Only four tandems include shredders—three Searby (all in Trinidad) and one Maxwell (British Guiana).

Shredders could probably be employed to advantage more extensively than is now the case, especially where the fibre in cane exceeds 13 per cent. There is also considerable scope for an extension of the principle of multiple milling. The tandems in the Islands are usually operated somewhat above normal rating, and those in British Guiana somewhat below. Table I summarizes the data collected from a number of mills operating in this area (1938-1940).

TABLE I.

Equipment.	No. of Tandems.	Rating.	Average. Imb. per cent. Fibre.	Average. A.J. lost per cent. Fibre.
9 Rolls	1	91·7	206·7	51·6
11 ,,	21	97·3	187·7	42·2
13 ,,	2	95·5	172·0	53·2
14 ,,	11	99·0	197·2	30·6
15 ,,	2	99·3	126·2	29·1
17 ,,	1	128·0	192·2	22·3

(2) *Cuba.*—Most of the information on Cuban mills has been obtained from "The Cuba Sugar Manual," 1937, supplemented by information from other sources. In the reference quoted, full particulars are not given for all tandems, and only those for which complete milling information is obtainable are included in the summary (Table II).

Milling practice in Cuba is most varied. The outstanding features of milling in this country are: (a) the high percentage of tandems with double crushers; (b) the large number of long milling trains; (c) the high percentage of factories at which juice sediments are returned to the mills for crushing; (d) the varied maceration practice; and (e) the considerable variation in ratings throughout the area.

It is the general impression that Cuban mills are operated at high ratings. Reference to Table II shows that on the contrary the average ratings are below normal except in the case of the longer trains (1937). According to MAXWELL[2], the development of double crushers and of long trains was the result of very rapid expansion of the cane cultivations, the increasing tonnages being handled by adding more units to the existing trains.

TABLE II.

Equipment.	No. of Tandems.	Rating.	Average. Imb. per cent. Fibre.	Average. A.J. lost per cent. Fibre.
11 Rolls	3	69·7	91·9	81·7
13 ,,	1	83·7	172·2	43·7
14 ,,	37	93·5	155·3	47·7
16 ,,	9	94·2	129·3	49·1
17 ,,	22	91·7	158·5	48·8
19 ,,	24	105·0	179·7	44·7
20 ,,	12	96·9	151·4	47·5
22 ,,	11	127·0	202·2	40·1
23 ,,	3	128·2	168·7	33·9

It will be observed that at the average imbibition used, the lost juice figures are high, resulting in overall mill performance indices below normal. This is due to the practice of returning muds to the mill for crushing, and to the fact that in many instances full compound imbibition is not practised.

[1] Association Reports and private sources. [2] "Modern Milling of Sugar Cane" (Norman Rodger, London).

The effect of these two practices are clearly shown in Table III, where the data for the various roller combinations have been arranged into three groups based on the milling practice in use. The grouping is as follows: (a) tandems at which juice sediments are returned for crushing; (b) tandems at which partial compound imbibition is practised; and (c) tandems at which full compound imbibition is in use.

TABLE III.

Equipment and Practice.		No. of Tandems.	Rating.	Imb. per cent. Fibre.	A.J. lost per cent. Fibre.	Performance Index.
14-Roller	(a)	4	101·0	155·6	54·9	82·4
Tandems	(b)	7	87·3	142·9	49·7	80·9
	(c)	6	111·9	146·7	42·1	99·9
16-Roller	(a)	5	95·3	123·4	55·3	81·4
Tandems	(b)	2	90·9	87·6	45·1	95·8
	(c)	1	100·0	185·1	27·3	100·6
17-Roller	(a)	11	91·1	155·0	51·7	74·6
Tandems	(b)	Nil	—	—	—	—
	(c)	2	94·9	142·5	34·3	94·2
19-Roller	(a)	11	103·8	207·6	46·1	76·3
Tandems	(b)	6	93·9	126·5	45·7	82·0
	(c)	1	81·7	185·1	27·3	87·6
20-Roller	(a)	8	100·1	151·3	47·6	78·4
Tandems	(b)	2	71·8	113·5	51·1	66·2
	(c)	Nil	—	—	—	—
22-Roller	(a)	2	86·8	208·6	52·1	64·6
Tandems	(b)	2	130·4	136·6	43·1	98·3
	(c)	1	137·4	259·6	23·3	108·4

It will be seen that the total number of tandems of various combinations does not add up to the totals in Table II. This is due to the fact that in some instances while the amount of imbibition applied is given, the maceration practice (whether partially or fully compound) is not stated; such tandems have been excluded from the data given in Table III.

From the above summary, it is clearly demonstrated that the return of juice sediments to the mills for crushing and the use of partial instead of compound imbibition, are instrumental in reducing the efficiency of milling. Of the two practices, the return of juice sediments has the greater deleterious influence. This is to be expected since this practice is generally accompanied by incomplete compound imbibition.

Using weighted averages, the overall mill performance indices are 76·9, 83·2 and 99·1 for return of sediments, partial compound imbibition and complete compound imbibition, respectively. There are, of course, arguments apart from the milling viewpoint in favour of these practices, but a discussion of them is outside the scope of this paper.

(3) *Hawaii.*—There is in general, greater uniformity in milling practice throughout this area than in most other cane-growing countries. The rating at which the mills are operated is uniformly low and imbibition uniformly high. As a result, high extractions are obtained and the figures for absolute juice lost per cent. fibre are extremely low (1931).

A special feature of milling in Hawaii is the importance which is attached to thorough preparation of the cane prior to crushing. In 1931, 90 per cent. of the tandems were preceded by knives (one-third having two sets) and over 25 per cent. had Searby shredders in addition to knives. The data for this area have been obtained from "The Hawaii Sugar Manual" (1932), and are presented in Table IV.

TABLE IV.

Equipment.	No. of Tandems.	Rating.	Average. Imb. per cent. Fibre.	Average. A.J. lost per cent. Fibre.
11 Rolls	7	64·2	222·0	19·6
12 ,,	8	60·4	260·2	18·5
14 ,,	15	68·4	261·0	16·3
15 ,,	2	61·3	257·6	13·5
17 ,,	4	89·5	247·8	22·8
20 ,,	1	74·4	266·0	11·5

(4) *India.*—The canes milled in this country are extremely fibrous. Most of the mills are operated in excess of normal rating and the imbibition applied is generally low.

In contrast to the difficulties in milling the Coimbatore seedlings experienced in other countries, in their country of origin these canes appear to possess normal fibre characteristics. Thus, while ratings are above normal, the efficiency indices are correspondingly low, and consequently the overall mill performance indices are approximately normal (99·2), a result which is not usually obtained with these seedlings elsewhere.

The majority of the Indian mills are preceded by knives, only 5 per cent. of the tandems in 1936 being without. In Table V are summarized the data of 11 Indian tandems at which the juice is weighed, and for which the necessary information is available.[1]

TABLE V.

Equipment.	No. of Tandems.	Rating.	Average. Imb. per cent. Fibre.	Average. A.J. Lost per cent. Fibre.
12 Rolls	3	115·3	109·3	54·3
14 ,,	3	106·7	111·2	44·5
15 ,,	3	104·7	101·2	48·2
17 ,,	2	116·5	117·1	49·2

(*To be continued*).

UTILIZATION OF DISTILLERY SLOPS.[2]—Joint research carried out by chemists of the Taihoku Imperial University and of the Sugar Experiment Station, Formosa, has resulted in recommending two processes for the treatment of distillery slops so as to utilize the potash as fertilizer, these being: (1) Evaporating down the slops to a high density, drying in the sun on a hard concrete surface until hardened, and lastly grinding to a powder; (2) evaporating down the slops to about 60° Brix, and adding sufficient powdered bagasse or lime-cake to give a dry mass suitable for transport. It is stated that steps are being taken to put these processes into industrial operation.

[1] "Year-book, 1936-37, Sugar Technologists' Association of India."

[2] *Sugar News*, 1941, **22**, No. 1, pp. 12.

Mechanical Circulation in Vacuum Pans.[1]

By G. H. JENKINS.[2]

Two designs of mechanical circulation pans have been described, and are no doubt familiar to the reader. Both use a mechanical device for pumping the massecuite down through the centre well, and consequently up through the tubes of the calandria. Smith's design[3] provides only one propeller in the centre well; while that of Webre[4] has four impellers, partially enclosed, to ensure movement of the massecuite throughout its entire depth. The former design with a centre well of half the pan diameter is designed to give good circulation even without a mechanical stirrer; whereas the Webre (in recent designs) has a centre well of one-third of the pan diam., and is specifically designed for mechanical circulation. The performance of these pans will be briefly reviewed in the following paragraphs.

Evaporation Rate.—At the beginning of the strike when the level is low and the viscosity of the massecuite moderate, rates of circulation and evaporation are not greatly increased by the mechanical circulator, the natural circulation being so effective that increased speed is scarcely desirable. After the strike has built up a few feet above the calandria, the mechanical circulator shows a definite advantage, and with a full pan of heavy low-grade massecuite, the evaporation rate may be as much as five times as great with mechanical circulation as it would be without. Figures reported by DUUS show that, with massecuite of a moderate Brix, the time for heavying up *C*-massecuites with the Webre pan at Tully was one-third of that for the coil pan used on similar strikes, while the total time for the strikes was 3·9 hours compared with 10·0 respectively.

For commercial sugar massecuites the gain in evaporation rate is naturally less than with low grades, but is still very marked especially when the massecuite is finished at a high concentration. It is evident that the value of a circulator will be greatest when massecuites are finished heavy; and with the modern emphasis on boiling heavy to obtain the maximum exhaustion at every strike, the value of mechanical circulation is greatly enhanced, as it promises to enable strikes to be dropped at higher densities than were previously possible.

Massecuite Temperatures.—Further measurements by WEBRE[5] showed that, with mechanical circulation the extent of the temperature differences was about one-fourth of that observed previously. With the more rapid circulation, moreover, the massecuite reaches the surface sooner and so is subject to the increased temperature for a shorter time. Thus the liability to damage by overheating is much reduced.

Few definite data are available regarding the effec of mechanical circulation on sugar quality. SMITH reports a decided improvement in colour of commercial sugar, though his tests disclosed no significant difference in filterability. DUUS reports two tests showing better filterability for *B*-sugar from the WEBRE compared with that from a floating calandria pan. Further results in this connexion would be of interest. It is probable that any such effects on sugar quality will again be more marked when massecuites are dropped heavy.

Use of Low Pressure Vapours.—The increased evaporation rates reported with mechanical circulation have been generally obtained even with reduced steam pressure. This fact renders it possible to use low pressure vapours instead of exhaust steam, thus opening the way to substantial improvements in steam economy. WEBRE[6] states that *C*-strikes have frequently been boiled with steam at five inches vacuum, with the massecuite carried as high as eight feet above the calandria. Such rapid heat transfer is not entirely dependent on mechanical circulation, since SMITH mentions cases in Hawaii where, in well-designed pans without mechanical circulators, rapid boiling of commercial sugar strikes was obtained with a vacuum in the calandria until the pan was about three-quarters full.

Performance of this order suggests that vapour from even the second effect of a typical evaporator set will be useful for pan boiling. When such rapid boiling can be obtained with steam at less than atmospheric pressure, the use of pressures of, say, 5 to 10 lbs. gauge will obviously give too high a rate of boiling. Hence it is essential, for proper control, to know what pressure is being used, and it is urged that for any fast calandria pan a large gauge on the calandria, reading vacuum as well as pressure, is as necessary as a proof-stick.

Elimination of Movement Water.—With an ordinary pan, when it is desired to hold the material at a practically constant supersaturation, as, for example, immediately after graining, the established practice is to use "movement" or "balancing" water, i.e., to add and re-evaporate water to maintain movement and to balance the water otherwise evaporated from the massecuite.

With mechanical circulation it should be possible to maintain the movement by means of the circulator and balance the rate of evaporation simply by reducing it, in other words, merely by throttling the steam valve to slow down the boiling as far as necessary, or even to stop it altogether. WEBRE has

[1] *Proc. Queensland Soc. Sugar Cane Tech.*, 12th *Conf.*, pp. 35-44 (here abridged). [2] Bureau of Sugar Experiment Stations, Brisbane.
[3] *I.S.J.*, 1933, p. 148; 1935, p. 118. [4] *I.S.J.*, 1933, p. 227; 1935, pp. 33 and 35.
[5] *I.S.J.*, 1933, p. 227. [6] *Ibid.*

repeatedly advocated such a procedure, and SMITH describes a technique actually practised where, after shocking at a suitable concentration, steam was shut off for 45 to 50 mins. and the grain "hardened" without using water.

If the quantity of movement water be estimated at the rather low figure of 4 galls. per ton of cane, the corresponding fuel requirement to evaporate this water amounts to some 50 tons of wood per week. Hence, if operation without movement water is possible, the fuel saving offered thereby is substantial. Following the same reasoning, some reduction in dilution of molasses at the centrifugals may also be possible, since it is sometimes contended that the molasses should be diluted sufficiently to promote circulation in the pan by the rapid evaporation of its water content. The possible saving here, however, is probably of a minor nature compared with that offered by the elimination of movement water.

Permissible Rate of Boiling.—It is generally considered that a low-grade massecuite must be boiled slowly in order to obtain good exhaustion. While this is perhaps partly "wishful thinking," since normally it is impossible to boil it fast with or without exhaustion, it is no doubt true that, on account of the low rate of crystallization of sucrose from low purity molasses, there is a corresponding limit to the rate at which water can be removed by evaporation without danger of forming false grain.

It would appear, however, that the value of this limiting evaporation rate would depend largely on the degree of circulation in the pan. If circulation is sufficient to give effective mixing of the massecuite so that the crystals are repeatedly brought in contact with a fresh film of molasses, the rate of exhaustion of the molasses will be increased correspondingly. Thus the writer contends that, with efficient mechanical circulation, a relatively high rate of evaporation is permissible even with low-grade strikes.

Near the end of a strike, however, the massecuite is very heavy and, even with mechanical circulation, is moving very slowly and the mixing action is sluggish. In these circumstances it is probable that the evaporation rate obtainable will be greater than that permitted by the rate of crystallization. This appears to be the cause of the formation of false grain while heavying up low-grade massecuites, as has been reported with some mechanical circulation pans.

In this case the boiling should be slowed down when this critical condition is reached; and, in view of the considerations given under the previous heading, it is suggested that this should be done by reducing the steam rather than by using movement water. Again, this cannot be done intelligently without a pressure gauge on the calandria. The use of water at this stage must be regarded as of doubtful value, since mixing of the water with such a heavy massecuite—even with the best feed distribution—must necessarily be slow.

With the present trend towards heavier massecuites of lower purity, conditions at the finish of the strike are especially critical; but it is considered that care in regulating the steam at the finish should still enable the formation of false grain to be avoided. It is presumed, of course, that the vacuum is carefully controlled; it is obvious that when the evaporation rate is some five times as fast, conditions require finer control than with natural circulation.

Crystallizer Elimination.—WEBRE has developed a neat technique for cooling the massecuite in the pan, with the aid of the mechanical circulator, thus doing the work of the crystallizer in the pan. This method has been found quite practicable and its utility in the average factory would depend mainly on the relative pan and crystallizer capacity available.

While separate water-cooled crystallizers would possibly be more efficient and more convenient where the maximum exhaustion is sought, a useful degree of preliminary "flash cooling" can be readily obtained in the pan by maintaining the vacuum and running the circulator for a time after shutting off the steam and before dropping the pan. This cooling is effected with better circulation than would be obtained in the crystallizer, and reduces the liability to form false grain when the massecuite is dropped into the crystallizer.

Power Consumption.—It has been found that a certain minimum circulator speed is necessary to effect any improvement over the natural circulation; and, further, that the power consumption is approximately proportional to the increase in circulation speed above that obtained naturally. Thus, in the early stages of a strike when natural circulation is rapid, the power consumption is low. As the strike proceeds the rate of circulation, though much lower than at the start, is high compared with the natural circulation obtainable under similar conditions. This fact, coupled with the greatly increased viscosity, causes the power consumption to rise to an increasing rate, giving a high peak load for a short time during the final concentration of massecuite. For a 5500-gall. pan, DUUS gives peak power consumption as 60 to 65 h.p., with an average figure of about 30 h.p.

Stirrer speed should be determined according to the duty required, and WEBRE has adopted the following speeds for 48 in. circulators in 12 ft. pans:

	r.p.m.
A, *B* and grain strikes	80
C strikes not over 96 to 97°Brix	60
C strikes 98 to 99°Brix	50

SMITH describes several pan circulators fitted with two-speed or variable speed drives giving a range of 30 to 50 per cent. on the maximum speed. A high speed can then be used to give the maximum circulation rate while the pan is being filled, while a lower speed for heavying up will enable the final concentra-

tion to be pushed to a high value with a moderate power consumption, yet retaining a circulation rate far greater than could be obtained with natural circulation. The writer would recommend a range of at least 30 per cent. on the maximum speed and, if any cooling of massecuites in the pan is to be attempted, at least 50 per cent.

Several of the installations mentioned by SMITH were equipped with steam turbine drives, the speed variation being obtained either by two-speed reduction gears or by adjustment of the turbine governor. It is stated that such a drive gives a reasonable steam consumption when the turbine speed is suitably chosen, and renders an entirely satisfactory drive available where generating plant is insufficient to permit of electric drive.

As regards the operating cost of the power required, this is very slight. When all exhaust steam is used in process, the heat and fuel requirements for power are practically only the theoretical heat equivalent of the power used. Calculated generously on this basis, the fuel required to drive four pan circulators, at an average of 20 h.p. each, is only some 18 per cent. of that required to evaporate movement water amounting to the low figure of 4 galls. per ton of cane, which, incidentally, indicates how inefficient movement water is as a means of promoting circulation.

Conclusions.—It is concluded that, while with high-grade strikes natural circulation pans of good design are satisfactory for ordinary present-day practice, the proper handling of high-Brix, low-purity low grades demands mechanical circulation. With the increasing quest for maximum recoveries, it seems safe to predict that mechanical circulation will become standard practice for low grades if not for all massecuites. While requiring rather finer control—as will any measures for improved performance—mechanical circulation will give much faster work, better quality sugar, improved exhaustion and better fuel economy than will be possible otherwise.

The Determination of Sucrose in Bagasse.

Some Observations on Boiling.[1]

By J. V. KIRKWOOD.

The importance of accuracy in the sucrose determination of bagasse is often stressed, and it was with this fact in view that certain variations from the official method of analysis were tried out. Three variations were examined, these consisting of the following :—

(1) *Omission of tamp.*—This simply means leaving off the perforated metal tamp with which the bagasse is kept below the surface of the liquid during the boiling period.

(2) *Vigorous stirring.*—In this case the tamp was left out and a metal rod with an improvised metal disc of wire network attached at one end was inserted through a hole in the lid of the digester. This was regularly moved up and down every 10 to 15 min.

(3) *Gentle simmering.*—The liquid was brought to the boil, and then the heat reduced until the solution was just simmering with barely any movement of the bagasse in the liquid.

In order to confirm the accuracy of the official method and determine the possibility of any sampling error, duplicate determinations by it were carried out before any of the foregoing tests were made. All these results were statistically analysed and the results summarized in Table I.

From these results we see that the omission of the tamp compared with the retention of the tamp, i.e., the official method, showed a significant difference, the official method being 8·43 as against the 8·30 sucrose per cent. bagasse. Where the tamp was left out, the bagasse did not sink below the surface of the liquid for at least 20 min. after introduction into the digester; this may be the explanation for a lower result, as the bagasse which had remained above the surface of the liquid had not had a sufficiently long immersion to permit of complete extraction.

Neither vigorous stirring nor a gentle simmer showed a significant difference from the standard method, although the means for each of these treatments were appreciably lower than those of the standard method. Vigorous stirring seemed to accelerate the saturation of the bagasse by the liquid and thus result in its being submerged and maintained in circulation. In the slow-simmer treatment it becomes apparent that, subject to the bagasse being kept below the surface and at boiling point throughout the extraction period, the extraction of the sucrose is not materially influenced.

BEHNE[2] has already established that the method developed in Java by KHAINOVSKY gave higher results than either the Queensland or the Hawaiian, as used in Queensland. As the apparatus for the Khainovsky method was not available, and as BEHNE had already found that the Queensland method[3]

[1] *Proceedings of the 15th Congress of the South African Sugar Technologists' Association.*
[2] *Tech. Comm. Bureau Sugar Expt. Stations, Queensland, Bulletin No.* 6; *I.S.J.*, 1937, pp. 304, 348, 390.
[3] "Laboratory Manual for Queensland Sugar Mills" (2nd ed.), p. 108.

gave higher results than the Hawaiian, it was decided to make a comparison between the official Queensland and the specified South African S.T.A. method.

The Queensland method was carried out by using a 1500 ml. Erlenmeyer flask and an air-reflux condenser of glass tubing; 100 grms. of bagasse were weighed into the flask and 1 litre of water containing 20 ml. of 5 per cent. sodium carbonate solution added. After shaking, the flask was closed and placed in a boiling water-bath for one hour, being shaken every 15 min. during this period. After cooling, the weight of the contents was determined and the extract polarized, using a 400 mm. observation tube. The sucrose per cent. bagasse was calculated as follows :—

$$\frac{\text{Wt. of extract} \times \text{Pol. of extract} \times 100}{100 \times 100}$$

where Wt. of extract = (wt. of bagasse + water after cooling) — wt. of fibre; Pol. of extract = from Schmitz' tables ÷ 2; the weight of fibre being assumed.

Parallel determinations were made on 22 samples of bagasse, and the results are shown in Table II.

It is seen that the sucrose per cent. bagasse as determined by the official South African S.T.A. method[1] is significantly higher than that determined by the Queensland recommended method.

BEHNE[2] found that the Queensland method (using a 1 to 10 dilution) gave a higher sucrose per cent. bagasse than the Hawaiian method, in which a dilution of 1 to 5 is used. This he attributed to poorer circulation in the Hawaiian method as a result of the reduction of the extraction water in proportion to the bagasse.

In our own official method we make use of a dilution of approximately 1 to 7. This will therefore not account for the higher sucrose per cent. bagasse obtained in our method compared to the Queensland method. In the Queensland method the contents of the digester never actually boils; in ours, as in the Khainovsky method, vigorous boiling occurs throughout the extraction period, thus affording free circulation of the liquid through the bagasse, and better extraction.

TABLE I.—SUCROSE PER CENT. BAGASSE.

	No. of samples.	Means.	Difference between means.	Standard error.	Test of significance of the mean difference.	"t" at (1) 19 : 1 (2) 99 : 1
(1) Official method—comparing duplicate samples	15	8·89 8·95	0·06	0·0919	0·6530	(1) 2·145 (2) 2·977
(2) Standard method compared with standard method without tamp	26	8·43 8·30	0·13	0·0423	3·0730	(1) 2·060 (2) 2·787
(3) Standard method compared against stirring every 10 to 15 minutes	26	8·43 8·34	0·09	0·0551	1·6350	(1) 2·060 (2) 2·787
(4) Standard method compared with allowing to simmer ..	13	9·23 9·12	0·11	0·0678	1·6220	(1) 2·179 (2) 3·005

TABLE II.—SUCROSE PER CENT. BAGASSE.

	No. of samples.	Means.	Difference between means.	Standard error.	Test of significance of the mean difference.	"t" at (1) 19 : 1 (2) 99 : 1
Official S. A. Sugar Technologists' method compared with recommended Queensland method	22	8·07 7·62	0·45	0·07134	6·3078	(1) 2·080 (2) 2·831

CUBA'S 1940-41 CROP.—According to Lamborn grinding was completed in Cuba by the beginning of June, the total crop working out at 2,442,708 long tons, raw value, as contrasted with 2,816,462 tons in 1939-40. This is the smallest crop in seven years or since 1934, the highest in that period having been 3,017,718 tons. The all-high record was 5,156,315 tons achieved in 1929.

RUSSIAN SUGAR AREAS AND THE WAR.—Unfortunately for Russia about 70 per cent. of its beet sugar industry is located in the Ukraine, mostly between Kieff and the Bessarabian border; most of the remaining beet areas lie between Kieff and Kursh. If the "Scorched earth" policy is applied to the lands of the Ukraine, it seems likely that any marked German advance in that province will destroy a considerable portion of the current Russian beet crop, even if the factories are left intact, which latter would be unlikely in terms of that policy.

MEASURING SUNLIGHT.—H. W. Brodie, of the Hawaiian Sugar Experiment Station, reports that efforts are still being made to develop a satisfactory method of measuring sunlight applicable to plantation conditions. Good possibilities, he states, are held by the method of observing the photochemical decomposition of oxalic acid sensitized with uranyl sulphate. It may prove to be a simple and inexpensive means of integrating light values.

UNITED KINGDOM SUGAR RATION.—The position of the sugar supply to the United Kingdom has apparently improved of late, to judge from the fact that during July the sugar ration was doubled to permit the use of sugar for fruit preserving by households. American sugar circles express reason for the belief that the British Ministry of Food has of late months made appreciable purchases in the Western Hemisphere, but neither details nor prices are available.

[1] South African Technologists' Association: "Recommended Methods of Chemical Control," p. 25.

Chemical Reports and Laboratory Methods.

Factors influencing the ERQV Milling Control Figure.[1] A. Udo de Haes. *Archief Suikerind. Nederl.-Indië*, 1940, 1, pp. 218-224.

It has not yet been definitely determined to what extent the ERQV as now used in Java in milling control may be affected by various conditions. It is expressed as follows :—

$$\frac{1{\cdot}4 \times \text{Purity raw juice} - 40}{1{\cdot}4 \times \text{Purity primary juice} - 40}$$

Low values may be due to : (1) bacterial decomposition of sugar at the mills ; and (2) to purity variations arising from the crushing of juices of different varieties some harder and some softer than others. To what extent such factors were likely to be of effect was the subject of an investigation carried out by the author at the Manishardjo s.f., where low values had been observed of late.

(1) *Bacterial decomposition.*—If at Manishardjo this factor had been of influence, it should have been shown by the following figures obtained during the past three crops :—

	1937.	1938.	1939.
Times the mills had been washed in 100 days	8	7	7
Primary crushing figure	69·4	70·5	72·4
Non-sugars removed in clarification, per cent.	33·4	30·2	28·7
ERQV	93·4	95·7	96·8

Now, since in 1937, the mills had been more frequently washed than in 1938 and 1939, the ERQV should have been higher in 1937 than in the other two years ; but this was not so. Nor had average ERQV's determined on the day before and the day after mill washing shown any appreciable difference ; nor again had the addition of a sterilizing agent to the imbibition water given a different figure from that found without such treatment. It may be, of course, that even under the worst conditions no great amount of bacterial sugar decomposition was occurring at this mill. As for other figures in the table above, the composition of the primary juice is known to have an important effect on the ERQV (as is proved below) ; while the non-sugars removed can be regarded as an indicator of the ash content of the juice, which very probably has some influence on the value.

(2) *Juice purity variations.*—It is well recognized that the greater the total crushing in the mills, the lower will be the ERQV. It is also known that with a heavier pre-crushing the purity of the primary juice falls, and that besides this the proportion of primary juice in the raw juice is greater. Both of these factors tend in the same direction to lower the purity difference between the primary and the raw juices, thus to raise the ERQV.

In order to obtain a closer insight into what may happen in practice, separate crushings were made of the rinds and centres of three different varieties from different fields, I without imbibition, II with single imbibition, and III with double imbibition, the average values obtained for the ERQV (Juice III / juice I) being as follows :—

	Rind.	Centre.
POJ 2878	85·6	93·2
POJ 2967	73·0	90·2
,, (different field)	74·7	95·7
POJ 2883	73·7	94·5

It was clear from the figures obtained what an enormous influence the composition of the cane exerts on the purity fall of the mill juices, and what variations may occur in the value of the ERQV in the case of juices from different cane varieties as such and the same varieties grown under other field conditions.

Evaluating Reagents used in Factory Control (Defecation Lime). C. R. von Stieglitz.[2] *Proceedings of the Queensland Society of Sugar Cane Technologists, 12th Conference*, pp. 57-59.

Sampling.—If the lime is in the form of large lumps, it is difficult to obtain a representative sample. About 1 lb. per ton should be taken to form the bulk sample, which is then reduced to a sub-sample of about ¼ in. diam. in a large iron mortar. Lastly a final sub-sample of about ¼ lb. is taken, ground quickly to pass a 0·5 mm. sieve, and placed in a screw-topped bottle. This serves as the sample for analysis, and if these operations have been carried out with despatch only a negligible amount of CaO will have been converted to $CaCO_3$ during the time taken.

Analysis.—So as to determine the "neutralizing power" of the lime, 1 grm. of the lime is weighed out into a 600 ml. Erlenmeyer flask, and 40 ml. of N/1 HCl added, the flask being placed on a steam-bath until the action has ceased, which should take about quarter of an hour. Unless practically free from sediment, the solution is filtered, and the residue washed well with hot distilled water. The filtrate is diluted to a volume of about 100 ml. with distilled water, and boiled gently for several minutes. After cooling, it is titrated against N/1 NaOH, using phenolphthalein as indicator. Then the ml. of N/1 HCl used × 5 = Neutralizing value per cent. expressed as $CaCO_3$.

Carbonate (which should be present only in small amount) is found by weighing 1 grm. of the material into a flask provided with a stoppered funnel, an inlet and an exit tube ; about 50 ml. of N/1 HCl is added through the funnel, and the flask heated almost to boiling point ; CO_2 thus evolved is passed through a Myer tube filled with 20 ml of N/1 NaOH, previously connected to the flask. Suction is applied to the other end of the Myer tube, so as to draw a

[1] *I.S.J.*, 1941, p. 185. [2] Bureau of Sugar Experiment Stations, Brisbane, Queensland.

stream of air through a soda-lime tower, the flask, and the Myer tube, suction being allowed to continue for an hour.

Lastly the N/1 NaOH solution is washed out of the Myer tube into an Erlenmeyer flask, the carbonate precipitated as $BaCO_3$ by the addition of 10 ml. of $2N$-$BaCl_2$, and the solution titrated back against N/1 HCl, using phenolphthalein as indicator. The ml. of excess NaOH multiplied by 5 gives the percentage of lime existing as $CaCO_3$, which figure subtracted from the neutralizing value given the active lime expressed as carbonate; this multiplied by 0·56 converts it to active lime expressed as CaO.

In an example, a neutralizing value of 170 per cent. has been found, and the percentage of lime present as $CaCO_3$ was 4 per cent.; then $170 - 4 = 166$ per cent.; and this $\times$ 0·56 = 93 per cent. of lime present either as CaO or $Ca(OH)_2$ expressed as CaO. While these methods described for the evaluation of active lime by the determination of the neutralizing value and the amount present as carbonate cannot be regarded as analyical methods of high accuracy, it is felt that they are sufficiently precise for the required purpose. Success with them depends very largely on the care taken in standardizing the N/1 acid and alkali solutions.

Rum Distillation, Use of a Bi-Rectifier. RAFAEL ARROYO, F. MARRERO and L. IGARAVIDEZ. *Annual Report for* 1938-39 *of the Agricultural Experiment Station of the University of Puerto Rico*, pp. 37-41.

It is pointed out that the manufacture of a good rum necessitates the constant supervision of the biological and chemical processes involved, and that an invaluable apparatus for the evaluation ot commercial and aging rums is the bi-rectifier of Dr. CURT LUCKOW, of the Berlin Institute of Fermentology, Berlin.

It reveals the true nature and constitution of the spirit under examination, and at the same time indicates under expert discrimination whether the rum under examination is a genuine product or not. It is also of invaluable assistance in following the maturing process of aging rums. It has been of great help to the authors in their rum researches, and is recommended to those interested in the manufacture of this or similar distilled spirit.

An idea of the work that can be done with the help of this apparatus will be obtained by a perusal of the general conclusions arrived at after the fractional distillations of over 20 samples of genuine rums. These may be summarized as follows:—

(1) The greater part of the low boiling point esters and aldehydes are obtained in the first two fractions distilled, probably in azeotropic admixture with the ethyl alcohol. These first distillates, although intensely aromatic, lack the original flavour of the sample under fractionation.

(2) During the distillation of the second half of the third fraction, ascending temperatures of distillation are registered. This indicates that chemical compounds of higher molecular weights begin to pass over at this point, especially the higher alcohols congeneric of ethanol.

(3) Still higher boiling point bodies pass over during the distillation of the 4th, 5th and 6th fractions. Some of these bodies prove to be insoluble, or only partly soluble in water, as starting with the 5th fraction great turbidity is first noticed, and later on standing oily drops may be seen floating on the surface of the distillate. This oily substance is known as "rum oil," and is one of the most valuable constituents of a genuine rum, especially of the Jamaica type.

(4) Fractions Nos. 7 and 8 are devoid of ethyl alcohol, but very high boiling point esters and aldehydes still persist in the last two portions of the distillate. Usually the turbidity of the distillate disappears in these last two fractions.

(5) The characteristic aromas of fractions Nos. 4, 5 and 6 recall better than those of any other fraction the original bouquet of the sample under fractionation. This is especially so in fraction No. 5. The highest molecular weight esters and aldehydes are also obtained during the distillation of fraction No. 5.

Economic Aspects of Synthetic Glycerin Production. E. C. WILLIAMS and Associates.[1] *Chem & Metall. Eng.*, 1941, **48**, pp. 87-89.—Amount of glycerin produced in the U.S. was 184 million lbs. in 1939, having steadily increased from 62 million lbs. in 1920. It is debatable whether, even if the recovery were increased to 90 per cent., all the fat-splitting plants could supply the further amount likely to be consumed in the near future in the various industries in which it finds increasing use, including plastics manufacture. There appears, therefore, to be a future for its synthetic production.[2]

Manurial Value of Molasses. A. K. MITRA.[3] *Proc. 9th Conv Sugar Tech. Assoc. India*, I, pp. 279-292.—In summarizing his general conclusions on this work, the author states molasses has a definite manurial value in increasing the yield of paddy, for which crop 100 maunds per acre appears to be the most economic dose. However, its application can only be profitable if its cost including transport charges does not exceed As. 0-3-0 per maund.

The Fertilization of Cane. I: A Simple Graphic Method of Evaluating Tests with Fertilizers. O. W. WILLCOX. *Facts about Sugar*, 1940, **35**, No. 12, pp. 33-37.—A method is described for applying the universal yield equation and the Mitscherlich criterion by means of a generalized diagram in which yields are plotted against Baulé units.

1 Research Laboratories, Shell Development Co., Emeryville, Cal. 2 *I.S.J.*, 1939, p. 408; 1940, p. 248.
3 Economic Botanist to Government, United Provinces, Shahjahanpur.

Abstracts of the International Society of Sugar Cane Technologists.

Under the scheme initiated by the International Society, a collection of abstracts of papers on agricultural and technical subjects is prepared monthly. A selection from these "Sugar Abstracts" has been made by us from the material last issued, and is printed below.

CANE AGRICULTURE.

A Field Trial of Portable Overhead Irrigation. H. R. SHAW. *Reports Hawaiian Sugar Technologists*, Third Annual Meeting, November, 1940, pp. 31-52.

The Waialua plantation has made an extensive experiment with overhead irrigation, using a system of permanent buried supply pipes and field hydrants at 100 ft. intervals to serve a system of portable pipes with sprinklers that are moved about the field as occasion requires. These pipes are 20 ft. lengths with quick-coupling joint and have a ½ in. service outlet for riser and sprinkler head; they are laid on the ground as lateral lines 100 ft. apart, at right angles to the main pressure line. The "Rainbird Model 80" sprinkler heads are apparently the most suitable type; they are attached directly to the portable pipe when the cane is young, and on 4 ft. and 8 ft. risers as the cane grows taller.

The experimental field covered an area of 105·9 acres of uneven topography, which made the expense of installation and operation somewhat greater than would be the case with a more favourable terrain. The distribution system was supplied with water through an electrically driven booster pump at a total cost for electric power of $11·76 per field acre per crop. Generally, thirty sprinklers are operated at a time, applying water at a rate such that the entire field can be irrigated in one round of twelve working days, with three men handling the portable pipe. Water is applied at the rate of 0·34 acre-inch per hour.

The reduction of quantity of irrigation water consumed in comparison with other methods was about 35 per cent. The experimental field was given 27·2 irrigations for the crop, as compared with the usual 40 rounds or more for the long-line surface method. Due to the circumstances of the field and the novelty of the operations, the area irrigated per man-day was somewhat less than is the average for long-line surface irrigation (around 3 acres per man-day as compared with 4 or 5 acres per man-day) but on the acre-month basis the comparison is more favourable on account of the reduced number of irrigations.

The yields from the first crop of the overhead irrigation field trial were very satisfactory. Field costs in practically every operation except those of electric power and pump attendant's wages were lower than for comparable plantation areas. However, in neither yields nor total costs was the performance exceptional as compared with the best records made on surface-irrigated fields, but the results justify a thorough economic and engineering study of the factors involved. The method seems to be particularly adapted to areas of limited water supply where gravity pressure can be utilized and to larger areas (800 to 1000 acres) where installation and operating costs will be considerably reduced. An important point will be gained if it should prove feasible to make the distributing system permanent instead of portable, for then direct labour costs for irrigation would be eliminated, which would be an advantage under conditions of a limited labour supply.

Windrowing Cane in Louisiana following Freezing Injury. J. I. LAURITZEN, C. A. FORT and R. T. BALCH. *U.S. Dept. of Agriculture Technical Bulletin*, No. 736 (1940.

The safest and best way to insure against freezing damage is to windrow unfrozen cane; i.e., by windrowing early and before a freeze. Unfortunately, to do so would, in many instances, involve some loss of sucrose, because in the absence of freezes cane often continues to grow, mature, and increase in sucrose content. Furthermore, except perhaps under special conditions, cane in the windrow loses sucrose through physiological inversion produced by the enzyme invertase, a normal constituent of the cane stalk.

The data reported indicate that so long as any eyes are sound at the time of windrowing, varieties Co 281 and Co 290 will windrow from three to six weeks under the usual weather conditions during the harvesting season in Louisiana without serious increase in acidity, decrease in *pH* value, and gum formation. In cane in which all the eyes, or all the eyes except an occasional basal eye, have been killed before windrowing, there may be a heavy consumption of solids at the expense of sucrose, although the development of excess acidity and gum is slow.

When all the eyes have been killed, the behaviour of cane in the windrow or in storage seems to depend upon a degree of injury at present not measurable by physical symptoms. Cane showing a lesser degree of injury may keep for a period of weeks in the windrow without souring or gum formation, whereas cane showing a greater degree of injury rapidly develops these changes. Weather conditions following windrowing do not appear to be responsible for this difference.

It is possible that the storage of cane so injured at a high temperature (say, 80°F.) may determine promptly whether or not such critical condition of injury has been reached and whether such cane is fit for windrowing. Cane that has been critically injured will deteriorate rapidly whether standing or in the windrow. Although certain lots of Co 290 show high

resistance to inversion, others show considerable susceptibility to it. The data justify the conclusion that it is safer and wiser, when possible and practical, to windrow cane before it has been injured by freezing temperatures. They also justify the windrowing of cane damaged by freezing temperatures in which sound eyes are found, as a protection against further injury.

Eye-Spot of Lemon Grass. B. A. BOURNE. *Phytopathology*, 1941, **31**, No. 2, pp. 186-189.

A wild host plant, on which the eye-spot disease of sugar cane may develop unnoticed has been discovered. The new host plant is lemon grass, and the disease has been observed on it throughout the year in the Florida Everglades. Another host plant for eye-spot disease is Napier grass, reported by VOORHEES in 1938. So far as is known this particular disease occurs only on these two wild host plants.

Nitrogen-Potash-Sunlight Relations. R. J. BORDEN. *Hawaiian Planters' Record*, **44**, No. 4, pp. 237-241.

The object of this experiment was to see whether the effect of sunlight and fertilizers are inter-related. For this purpose cane plants fertilized with different amounts of nitrogen and/or potash were exposed for different lengths of time to sunlight.

The data obtained show that different exposures to sunlight have very different influences on the effect of different applications of nitrogen. Under full sunlight conditions high nitrogen gave increased cane yields which were only slightly, if at all, of poorer quality than were obtained from a more moderate amount of nitrogen.

On the other hand, when the time of exposure to sunlight was decreased, the high nitrogen not only did not increase the cane yield, but it definitely produced a cane of poorer quality and less sugar content. Until full sunlight the sugar yield was adversely affected only when the amount of nitrogen used was excessive.

The result definitely suggests that when cane is grown under conditions where sunlight is apt to be deficient, high nitrogen applications must be avoided or maximum sugar yields will not be obtained. If extra nitrogen applications are to be given, it would appear to be wise to accompany them with extra potash, since there appears to be a point of balance between these two nutrients which can have a special effect on juice quality.

Chlorotic Streak in Louisiana. COMMITTEE REPORT. *Sugar Bulletin*, 1940, **18**, No. 18, pp. 2-3.

In view of the definitely known presence of the chlorotic streak disease of sugar cane in Louisiana, the committee visited several fields where the disease was found in 1938.

The harmful effect of the disease can readily be observed on stubble cane. Diseased stools are much smaller than healthy ones, germination is poorer, suckering is less, and a much smaller yield may be expected than from healthy cane. The effect of the disease is far greater than one would expect, judging from the small amount of discoloured leaf surface.

Last year certain individuals and companies, in an attempt to control the disease, rogued the seed plots from which plantings were made for the 1939 plant cane crop. This rogueing was done rather late in the year, which means that it was done under adverse conditions and those who followed this practice at that time were uncertain whether or not they were justified in this effort to control the spread of chlorotic streak.

The Committee examined the fields in which the rogued cane was planted and found a very small amount of diseased cane. The rogueing, which was done under adverse circumstances, seems to have been effective, and the results obtained seem at this time to have fully justified the effort and expense involved.

Conclusions formed by the Committee are :—

(1) That the effect of the disease on individual plants is very serious, and that the industry will be very harmfully affected if we have a large percentage of infection. It is particularly harmful to CP 29-320 and 2819. (2) That by selecting as seed plots those areas which show no infection, or only a small amount of infection, and by rogueing such plots, beginning while the cane is small, effective work can be done in controlling the spread of the disease.

BEET AGRICULTURE.

Beet Seed Production by the Danish Method. H. WICKENDEN. *British Sugar Beet Review*, 1940, **14**, No. 4, p. 55.

In Denmark the majority of seed producers sow the stock seed in a nurse crop of barley or on fallow or even on ploughed-up barley stubble in the field where the seed is to remain. No hand hoeing is done, and no transplanting. In the spring thorough cross cultivation is given to the crop and weakly plants and weeds are removed. Subsequent work up to harvest time is confined to horse-hoeing between the rows.

Three advantages are claimed for this method : firstly, a great saving of hand labour cost ; secondly, the plants are said to thrive better by not being disturbed during their period of growth ; thirdly, the plants that survive the outwintering and cross cultivation are the strongest and the result is a heavier yield of greater vitality and vigour than by the usual method.

Some preliminary experiments with this method have given results indicating that it may be successful in England.

Dusting Beets for Blight. M. W. SERGEANT. *New Agriculture*, 1940, **22**, No. 5, pp. 10-11.

In the year 1935 the leaf spot (blight) disease in certain sections was so severe as to result in exceptionally low yields. This disaster directed new attention to the previously known counter-measure of applying a

copper-lime fungicide. The results in numerous areas are here summarized.

Increased yields of from 1¼ to 6 tons were obtained at costs not in excess of $4·80 and 5·00 per acre. The author observes that the results of the past two years' large scale commercial dusting have completely changed the picture in blight-infested areas. The question is no longer whether it pays or not but what equipment, what fungicidal mixtures, and what methods are the most efficient and most economical.

Beet Technology.

What to do with Sugar Factory Press Mud. O. Spengler. *Zeitsch. Wirtsch. Zuckerind.*, 1940, **90**, No. 9-10, pp. 352-356.

The large piles of press muds that accumulate on the premises of a beet sugar factory present a problem upon which much attention has been bestowed. Since this material contains much of the valuable non-sugar components of the beets, a logical disposal of it would be its return to the beet fields. However, the beet growers are not everywhere disposed to accept it for this purpose for two principal reasons.

One reason is its large moisture content, which gives the stuff a tendency to form clumps that are difficult to handle with the usual farm implements for spreading lime and fertilizer. One German factory has solved this problem by drying it according to the Rema-Rosin method. The product is then easy to spread and is willingly taken by farmers who have acid soils.

On the other hand, the farmers whose soils are not acid feel no need of the material, and are the more disinclined to use it because of the supposed relation between soil alkalinity and the heart rot disease of sugar beets. To such farmers it is pointed out that it is now well known that the sugar beet makes its optimum growth in soils that have a *pH* somewhat above 7·0, with a second maximum in the neighbourhood of *pH* 8·0. Even very large additions of press mud, which is mostly calcium carbonate, do not raise the alkalinity of the soil to a harmful figure, and as for the heart rot disease, this is easily controlled by the use of borax, as is now well understood. Even on soils that are not acid, the press mud is valuable because it can greatly improve the physical character of the soil and contributes worthwhile plant food in the form of nitrogen and phosphoric acid.

In the meantime other prospects of dealing with this by-product are being opened by investigations on the possibility of dispensing with the usual main-liming operation in juice purification. It has been established that complete precipitation of the impurities can be effected with not more than 0·2 per cent. of CaO on beets. This precipitate contains a minimum of calcium carbonate and a maximum of organic substance that has value for stock feeding, so that it can be mixed with beet pulp or at least siloed with beet tops. In fact, it is now used to a certain extent as a mixture in commercial dried beet pulp (*Ternoschnitzeln*). However, the difficulty here is the filtration of this precipitate, and it is this difficulty which it is hoped to remove by further experiment. As matters now stand it still requires 0·4 to 0·6 per cent. of CaO on beets to obtain a satisfactory filtration, which produces a quantity of mud too large for disposal in its entirety as stock feed.

Beet Sample Washer. J. G. Lill. *Journal American Society of Agronomy*, 1940, **32**, No. 12, pp. 973-974.

This washer consists essentially of a tank about 36 × 34 × 30 in., and a rotating skeleton drum containing the cages or baskets in which the samples of roots are placed. Each of the cages consists of a top and a bottom section. When the rotating drum is stopped at the proper point, the top section, which is hinged to one of four cross bars spaced circumferentially at 90° intervals, can be turned up and forward to a position where the washed roots will fall out.

The drum and cages revolve at 15 to 20 r.p.m.; the water is gently stirred by baffles on the inside of the cages. The thoroughness of the washing is governed by the length of time the sample is kept in the rotating machine. Since the beets are in water all the time they are being washed, root breakage is reduced to a minimum.

New Juice Purification Process with Simultaneous Defecation and Carbonatation at Low Alkalinity. G. Oplatka and J. Barcsay. *Centr. Zuckerind.*, 1940 **48**, No. 43, pp. 760-762; No. 44, pp. 783-786.

In laboratory and factory-scale experiments it was found that addition of small amounts of milk-of-lime at short time intervals to the raw juice during the first carbonatation, at a rate such that the alkalinity of the juice does not exceed certain limits, results in very appreciable advantages. This process appears to be new, at least it is not used in Europe as far as the authors have been able to find out.

The only somewhat parallel procedures found by them in the literature are the De Haan process (used in the Java sugar industry), and Dorr's German patent No. 638,478; the Dorr patent describes simultaneous defecation and carbonatation, but makes no mention of the limits within which the alkalinity is held. The point of process described here is to keep the CaO content between 0·07 and 0·12 per cent.

The chief advantage of the new process is that the purity of the thin-juice is raised 0·5 to 1·0 point above the result obtained before carbonatation. The amount of lime salts in the juice is reduced, and there is less foaming and less incrustation in the evaporators. The authors think that their process will be of interest to the cane sugar industry because by keeping the alkalinity low there will be little destruction of invert sugar; it will then be possible to use more lime and obtain better filterability.

In commenting on this new process, H. CLAASSEN[1] observes that since the authors used thymolphthalein to control the process they doubtless kept under the upper limit (0·12 per cent. CaO) but very likely went below the lower limit (0·07 per cent. CaO) and even passed momentarily into the region of over-carbonatation. This occasional and momentary over-carbonatation would undoubtedly have a shrinking effect on the flocs of precipitate, which would account for the better filterability, without any unfavourable effect on the juice. An important point that remains to be settled is whether the new process offers an advantage over the fractional or pre-liming process now well established in central European factories.

New Books and Bulletins.

Applied Mycology and Bacteriology. By L. D. GALLOWAY, M.A., and R. BURGESS, M.Sc., Ph.D. (Leonard Hill, Ltd., London). vii + 186 pp. 1940. Price : 10s.

This is the second printing of a small book published in 1937, which has been well received. Anyone desiring to obtain an insight into the theory and practice of the sciences of bacteriology and mycology in the shortest possible time could hardly do better than study it. Part I has chapters describing fungi, bacteria and micro-organisms generally, on the laboratory apparatus and culture media used in their investigations, and on the technique of their propagation, isolation and examination. Part II deals in a general way with the application of mycology and bacteriology to the arts and industries. It outlines, for example, the essential principles concerning food spoilage, fermentation, textiles, hygiene and agriculture. At the end of each section are references to the most important literature on the subject discussed. It is certain that this brief survey of the field will be found of much service to chemists and others desiring to co-ordinate their studies with those of other workers. It effectively indicates the methods, scope and importance of modern microbiology.

Power Alcohol. (Queensland Cane Growers' Council, Box 1032N, Brisbane). 1940.

In view of the public interest being taken in the value of power alcohol as a fuel for internal combustion engines, this pamphlet has been published to give general information on the subject. It describes in a simple manner the processes of fermentation and of distillation for the production of power alcohol (absolute) of 99·5 to 100 per cent. It points out that such power alcohol can be used neat in special engines, but to avoid altering carburettors or other mechanism in ordinary automobile engines it is best used in admixture with petrol in the proportion of 15 to 20 per cent. Alcohol at 95 to 96 per cent. cannot be used as it will not mix with petrol owing to its water content, whereas 99·5 to 100 per cent. alcohol will mix in all proportions without separation. It is not desirable to use more than 15 to 20 per cent. of alcohol in a petrol mixture, because in this proportion it gives the maximum improvement to the petrol, and increases its anti-knock value.

Manufactura de Ron. RAFAEL ARROYO. (Circular 106, Agricultural Experiment Station, University of Puerto Rico). 1938. (In Spanish).

Contents : Importance of the proper selection of the yeast ; selection of the raw material ; pre-treatment of raw material ; fermentation ; distillation ; curing the raw rum ; chemical and biological supervision of the distillery ; and the best equipment of a distillery.

Sugar Cane for Syrup Production. E. W. BRANDES, S. F. SHERWOOD AND B. A. BELCHER. Circular No. 284 ; U.S. Department of Agriculture, Washington, D.C., U.S.A. (For sale by the Superintendent of Documents, Washington ; price 10 cents).

Contents : Varieties of cane ; selection of land ; manurial requirements ; preparation of the land ; planting, cultivation, harvesting yields ; storing cane for planting ; diseases and insect pests ; labour and animal-work requirements ; marketing the syrup ; and utilization of by-products.

Sugar Beet Culture. S. B. NUCKOLS. Farmers' Bulletin No. 1867 ; U.S. Department of Agriculture, Washington, D.C. U.S.A. (For sale by the Superintendent of Documents, Washington, price 10 cents).

Methods of growing beets in the irrigated districts of Nebraska, Wyoming and South Dakota are described in this Bulletin, the problems with which the average grower is confronted being described in non-technical language. Its contents are : Climatic influences ; land selection ; crop rotation ; manures and fertilizers ; seed-bed preparation ; seeding, hand-blocking and thinning, mechanical blocking and cross-cultivation, hoeing ; irrigation ; harvesting ; and by-products.

[1] *Centr. Zuckerind.*, 1940, 48, No. 47, p. 833.

Sugar-House Practice.

Crystallizer Operation in the Cooling of Low-Grade Massecuites. J. M. VAN DER ENT.[1] *Archief Suikerind. Nederl.-Indië,* **1,** No. 13, pp. 291-296.

In the Gempolkrep s. f. Java, an investigation was carried out for the purpose of following the course of massecuite exhaustion during the operation of cooling. An 0-shaped crystallizer, 5 m. long and 1·8 m. diam., provided with a water-jacket, and rotating at the rate of 2·75 revs, per min., was used. Besides being provided with thermometers, a pair of electrodes was fitted in the wall of the crystallizer for the purpose of conductometric control (as in pan boiling). Rates of cooling, and the extent of dilution, were varied, and from the data obtained the following conclusions were arrived at :

Massecuite Number.	Exhaustion coefficient. After 4 hours.	After 20 hours.	Increase per cent.	Cooling method.
271	0·80	0·91	14	No water
284	0·88	0·99	12	,,
295	0·93	1·09	17	Water, 6 hours
311	0·79	0·94	19	,,
372	0·82	1·00	22	Water, 10 hours
381	0·83	1·03	24	,,
400	0·82	1·03	26	,,
418	0·86	1·05	22	,,
435	0·99	1·16	17	,,
452	0·92	1·10	20	,,
470	0·80	1·03	29	Water, 15 hours
Averages :				
271/284	0·84	0·95	13	No water.
295/311	0·86	1·01	17	Water, 6 hours
372/452	0·87	1·06	22	Water, 10 hours
No. 470	0·80	1·03	29	Water, 15 hours

Figures were obtained showing that the extreme exhaustion of a molasses massecuite in the crystallizer is determined in the main by the state of exhaustion of the mother-liquor at the commencement of the process of cooling, in other words, the massecuite must be exhausted as fully as possible in the pan before it goes to the crystallizers, it being impossible in the crystallizers to adjust errors made in the pans.

Dilution in the crystallizer, either with water or with diluted molasses, slows down exhaustion very considerably, and should be avoided unless special circumstances make it desirable, or unless there is plenty of crystallizer capacity. In this last case, the massecuite can be diluted a few hours before centrifuging to make it more readily curable.

The value of the saturation coefficient (as calculated by SIJLMANS[2] formula) has little effect on the rate of exhaustion, at least within the limits of 1·05 and 1·20. If it falls below the lower limit the rate of exhaustion is noticeably decreased.

Cooling by means of a water-jacketed apparatus, as was used in these experiments, is definitely effective, it being thus possible to reduce the temperature to a sufficiently low degree within a reasonable time, the accompanying table being given to show this.

Variations in the saturation value are well indicated by means of the milliammeter, which also clearly indicates the dilution of the massecuite. However, the correlation between its readings and the temperature are not well marked. It may therefore not be possible always conclusively to apply this method of conductivity control to the crystallization process.

Main A.C. Switchboard Equipment. A. COYLE.[3] *Proc. Queensland Soc. Sugar Cane Tech., 12th Conf.,* pp. 113-116

In the writer's opinion the following switchgear and instruments should be provided on alternator panels. It may be considered that these instruments involve a costly outlay, but they are a permanent asset and extra benefits gained soon offset the extra cost :—

(1) An oil switch of ample capacity, protected on three phases with suitable inverse time lag trips, this being preferable to open switches or circuit breakers, since it can deal more adequately with heavy short circuits. (2) Two voltmeters, one for the bus bars and one for the incoming alternator ; a floating plug can be used to connect any alternator to the second voltmeter, thus avoiding the necessity for separate voltmeters on each panel. (3) A frequency meter, preferably of the two dial type, connected to the same source as the voltmeters to register simultaneously the frequency of both the bus bars and the incoming alternator and be of assistance when synchronizing. (4) A synchroscope. (5) Three ammeters, with a selector switch to connect each phase in turn, since in the former case unbalanced faults are immediately detected and more quickly remedied. (6) An indicating kilowatt meter is useful for balancing loads since the operator can see immediately the output of each machine. (7) A kilowatt-hour meter enables hourly readings to be taken and a record kept of units generated over any period of time. (8) A power factor meter on each alternator panel, since each machine

[1] *Internationale Crediet en Handelsvereeniging "Rotterdam."* [2] *Archief,* 1934, 42, II, p. 167 *et seq.* [3] Of Tully Mill, Queensland.

can then be regulated, according to the power factor, to carry the correct load. (9) An ammeter on the alternator field to record current and to check the field system. (10) An alternator field switch fitted with discharge resistance permits the operator to open the alternator field immediately after the main switch has been opened in cases of extreme emergency (as a short circuit or fire in the alternator windings or in the wiring between alternator and switch). (11) Reverse power relays, to prevent current from flowing in the opposite direction in the alternator winding due to exciter or engine trouble, useful also when shutting down a machine, as the main switch will open when current reverses. (12) Current transformers to enable all instruments to be connected by light wiring without any of the main or heavy current flowing through any of the instruments. (13) Isolating switches to allow repair work to be done on individual panels whilst the rest of the switchboard is alive.

Feeder panels should be adequately equipped and it is considered that the following are essential for reasons similar to those advanced for alternator panels : (1) An oil switch of ample capacity protected on three phases with suitable inverse time lag trips ; (2) ammeters on each of the three phases ; and (3) an isolating switch at rear of panels. All these instruments are used in central power stations and if they are necessary for correct operation there, they are also necessary in a sugar factory.

Off-Season Corrosion in the Sugar Factory. C. W. WADDELL. *Proc. Queensland Soc. Sugar Cane Tech., 12th Conf.*, pp. 205-206.

During the crushing season, there is a very large area of mild steel and cast iron which is covered by process materials ; some surfaces become polished bright by the movement of materials over them, whilst others are coated with scale, scum or muck, which provide a certain amount of protection against "rusting" When the crushing season is over, however, many of these surfaces are in an ideal state to promote rusting during the five to seven months off season.

"Our choice appears to lie between : Coating such surfaces with a material which will survive the crushing season action of process materials, the cleaning periods at week-ends and at the close of the season, and the long exposure to damp air during the off season ; or coating the surfaces with a material which is designed only to last for the off season.

"After several years of search, test and observation, in an effort to try to beat the problem upon a long term cost basis, the writer is inclined to believe that the answer will be found in a cheap, temporary covering rather than in the use of a permanent one.

"No paint or covering yet appears to be capable of standing up to the "hammer and chisel action" of, for instance, bagasse upon the inside of conveyors, gritty juice in flumes, the rush of vapours and water through condensers, or the weekly cleaning of tanks

"It seems to be quite within reason to believe that search will discover a liquid which will have the following specifications : When applied to mild steel or cast iron the surface will be protected from corrosion and rust for the seven months off-season ; it should preferably be waterproof, although the surfaces are not exposed to rain ; it must be easily applied, preferably by spray gun ; it should not be highly poisonous, and above all, it must be cheap enough to justify its application each year.

"In an average Queensland sugar factory, the inside surface areas in the class under discussion may add up to somewhere in the vicinity of 40,000 sq. ft. Preliminary enquiries in Brisbane, and tests made to date, indicate that a liquid costing about 3s. 9d. per gallon will do the job. If we secured a coverage of only 300 sq. ft. per gallon, the cost of material would be about £25 per year. If we allow 3000 sq. ft. covered by one man with a spray gun, the cost of application may add another £15 per year.

"Our annual depreciation, maintenance and replacement costs run into four and five figures, and an expenditure of £40 would probably look very small against that portion of these which can be charged to "off season corrosion." Another item over which many chemists and engineers have pondered is the treatment of the insides of steam, juice and water pipes which are exposed to corrosion during the off-season. Filling them with water is not a satisfactory answer. Pumping a dilute resin-soda solution through them at the close of the crushing season has been found partially satisfactory, but needs improvement."

The Continuous Pressure Feeder. H. E. B. SCRIVEN. *Proc. Queensland Soc. Sugar Cane Tech., 12th Conf.*, pp. 159-163.

One of the many improvements which the Colonial Sugar Refining Co., Ltd., has introduced into the Australian sugar industry is an apparatus which by virtue of its functions has come to be known as the continuous pressure feeder. It is essentially a combination of a pair of rollers ahead of the last mill, together with a pressure chute leading to the feed side of the mill.[1] Some information may now be given of the results which have been obtained by the operation of this device.

Pre-crusher rolls had been previously tried ; but until the advent of the continuous pressure feeder there has been developed no contrivance which combines both the removal of surplus moisture and continuous feeding under pressure of the mill rollers. In contrast to the intermittent working of pushers

[1] See Australian Patent, No. 107,721 ; *I.S.J.*, 1940, p. 153.

and like contrivances, the continuous pressure feeder presents a constant and uniform supply of semi-dried bagasse to the mill rollers in such a manner that they are forced to take the feed.

Experience has shown that this combination of effects results either in an increased tonnage through the mill, a lower moisture content of the bagasse leaving the mill, or a combination of both these desirable features. It is difficult to give figures on the performance obtainable with the c.p.f., owing to their variation with local conditions, and especially with the type of cane being milled; but it can be stated with a reasonable degree of certainty that installed on the last unit of a 4 mill train this device will reduce the final moisture by about 4 per cent.

Pushers form a comparatively crude mechanism, wasteful of energy and costly in maintenance, whereas the c.p.f. is uniformly efficient, given conditions ensuring a steady feed. Principal among these conditions are the absence of "lumps" arriving at the chute, which has been ameliorated by means of a set of rake tines to smooth out the lumps and give a uniform flow of bagasse into the top chute of the feeder.

A reduction in final moisture means an improved total extraction, the value of which can be expressed as sugar in the bag, thus determining the financial value of the investment. Besides the higher fuel value of the dried bagasse should be taken into account. Of course if advantage is taken of the installation to increase the crushing rate, then the reduction in final moisture cannot always be maintained.

A possible application of the continuous pressure feeder which may be realized before long is its use on the second and third, as well as on the fourth mills. Its fitting to the first mill is not a very simple matter in Queensland, due to the mechanical arrangement of the preparatory devices, but its operation in conjunction with each of the succeeding mills should represent a definite improvement on that of the intermittent pushers, because of the advantages to be obtained from a steady and continuous feed.

Removal of some 50 per cent. of the surplus moisture from the bagasse entering each mill will enable the mills to work with a closer setting to obtain a higher extraction and to deliver drier bagasse to each succeeding intermediate carrier. Also the bagasse will contain less sucrose so that subsequent maceration will be more effective. Thus the combination of a continuous pressure feeder with all mills except the first should be definitely advantageous.

Influence of the Boiling System on the Quality of the Raw Sugar obtained. R. E. Diago. *Proc. 13th Conf. Assoc. Sugar Tech. Cuba*, pp. 203-210.—Experience during many campaigns have led the writer to believe that in most cases the colloids of the cane juice are not the cause of a low raw sugar filtrability, but rather that it is due to the presence of finely divided insoluble impurities, which may not be true colloids. They consist of very fine insoluble matter of a viscous nature, which may well be classed as "semi-colloids." Laboratory tests have shown that the pre-filtration of defecated juice results in a positive improvement of the filtrability of the syrups obtained therefrom. Be this as it may, there is no direct relationship between the filtrability of the syrup and that of the raw sugar resulting from it. Sometimes sugars of low filtrability are obtained from syrup of good filtrability, and sometimes the contrary is found to be the case. This points to vacuum pan operation as the limiting factor in the filtrability of raw sugar. In fact, it is concluded from the author's observations obtained in different crops in Cuba that a substantial improvement in the filtrability figure for raw sugar and in its colour may be achieved by establishing the 4-massecuite vacuum pan boiling system with the double purging of the 4th sugar.

The Boomer (H.T.A.) Sugar-Weighing Scale. E. F. H. Delfgou. *Archief Suikerind. Nederl.-Indië*, **1**, No. 13, pp. 318-321.—It is a cross-beam apparatus in the form of a large equi-armed balance, one pan serving as the weighing platform, and the other as the tare-weight scale. It is said to be very strong, its sensitivity after the weighing of 100,000 sugar bags remaining unchanged. Its sensitivity is said to be such that loaded with one bag of sugar it will indicate an over or under weight of 100 grms. Its dimensions are given in a drawing, and it is also illustrated in photographs. It is sold at a moderate price.

Buffer Effect in the Inversion of Molasses. Benigno R. Argüelles. *Proc. 13th Conf. Assoc. Sugar Tech. Cuba*, pp 195-198.—Different proportions of molasses and partially inverted syrups were so compounded as to give mixtures with ash contents varying by 0·1 per cent., the *pH* and other factors remaining constant. Each of the mixtures was in turn treated with increasing amounts of sulphuric acid (sp. gr., 1·83), and the resulting *pH* values then read. Different *pH* values were thus obtained for each of the mixtures, showing the buffering effect of molasses to be variable with the original ash content, and with the amount and the nature of the organic acids resulting from the treatment given in the clarification stage. Electrometric ash and *pH* methods are advocated in the production of invert syrups and molasses.

The Farrel-Scharnberg Cane Mill. P. V. Tippet. *Facts about Sugar*, 1940, **35**, No. 11, pp. 38-40.—This is an illustrated description of the new type of mill built for the Clewiston plant having boltless housings and free-floating top roll, particulars of which have already been given.[1]

[1] *I.S.J.*, 1941, p. 128.

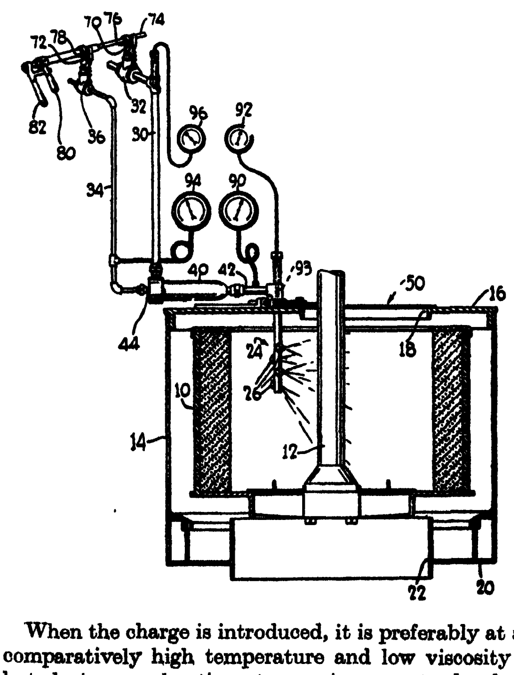
Review of Recent Patents.

Copies of specifications of patents with their drawings can be obtained on application to the following—*United Kingdom*: Patent Office, Sales Branch, 25, Southampton Buildings, Chancery Lane, London, W.C.2 (price 1s. each). Abstracts of United Kingdom patents marked in our Review with a star (*) are reproduced with the permission of the Controller of H.M. Stationery Office, London, from the Group Abridgements issued by this Department. Sometimes only the drawings are so reproduced. *United States*: Commissioner of Patents, Washington, D.C. (price 10 cents each). *France*: L'Imprimerie Nationale, 87, rue Vieille, du Temple, Paris. *Germany*: Patentamt, Berlin, Germany.

UNITED STATES.

Centrifuging and Washing Massecuites. EUGENE ROBERTS and GEORGE E. STEVENS (assignors to the WESTERN STATES MACHINE CO., of New York). 2,223,663. December 3rd, 1940

Use of steam for washing m.c. leads to inferior results (states the preamble of this specification), because of its poor penetration of the sugar wall, and its characteristic of dissolving too much grain before the average purity of the sugar can be brought to a satisfactory point. Warm water also has failed to give the desired result. Even the application of a fine hot water spray through a spray nozzle under considerable pressure fails to wash the crystals of a very fine grained or smeared m.c. satisfactorily without using large quantities of water, leading to the solution of large amounts of the crystals.



When the charge is introduced, it is preferably at a comparatively high temperature and low viscosity; but during acceleration strong air currents develop inside the basket and cause a substantial reduction of the temperature, especially near the inside face of the sugar wall. Congealing of syrup in the case of smeared m.c. sometimes prevents mother-liquor from passing through the inner portion of the sugar wall, leading to the formation of a tough "skin" there. Under these conditions even fine hot water spray at 170 to 200°F. becomes reduced in temperature, and the desired result is not achieved.

It has now been found that much of the difficulty heretofore encountered may be avoided by the application while the basket is revolving at high speed of a very hot mist consisting of both liquid and steam at a spray nozzle temperature well above 212°F.—viz., up to 250°F. without damaging the sugar crystals, this permitting a large volume of liquid to pass through the sugar wall in a short interval of time. Notwithstanding the cooling influence of air currents, the temperature of the mist striking the inside face of the sugar wall remains high enough to raise the temperature of locally cooled areas, and largely to cure their tendency to prevent efficient washing and drying of the crystals. Moreover, this treatment results in the immediate melting of any "skin" on the sugar wall.

An alternative but less desirable procedure is to provide a supply of superheated water under pressure for admission to the spray nozzle during the washing stage. A hot mist of water and steam is produced from the nozzle and sprayed upon the charge in the basket when the pressure is released. In this embodiment of the method, the water is preferably held at a temperature of about 225 to 250°F. Reference should now be made to the drawing herewith illustrating an arrangement of apparatus for carrying out the present invention.

The machine with its perforate basket 10 has a curb top 16 with a central opening 18 and a curb bottom 20 with a central opening 22. Spray nozzle 24 is mounted on the curb top, having outlets 26 directed towards the sugar wall. A supply of hot water (not shown) is provided under pressure to a water line 30 with valve 32; a supply of steam (not shown) is provided under pressure for admission to a steam line 34 with valve 36.

Means are provided on the top curb 16 for combining the steam and hot water to form a very hot mixture suitable for delivery through the nozzle 24. A cover 50 is preferably provided on the curb top 16 for closing the opening 18 during the spinning cycle. While either the top opening 18 or the bottom one 22, or both, may be covered to advantage, the use of a top cover only gives satisfactory results.

Use of the present invention in the centrifuging of extremely fine grained white massecuites, compared with the best prior practice, permits by shortening the cycle an increase of capacity of from 8 to 20 per cent.; it also allows the amount of wash-water to be reduced from 25 to 40 per cent. with a proportionate reduction in the solution of sugar crystals; and it

finally produces centrifuged sugar of lower moisture content. Improvements of similar extent are obtained in the treatment of other types of massecuites and magmas.

Claim 6.—The method of washing syrup from sugar crystals in a revolving centrifugal basket which comprises providing a supply of hot water at a temperature between 160 and 200°F., and under a pressure between 20 and 70 lbs per sq. in., providing a separate supply of saturated steam under pressure of between 20 and 70 lbs. per sq. in., leading streams of said water and steam together and co-mingling the same and spraying the resulting hot mist of superheated water and steam into the charge in the basket.

Claim 7.—The method of washing syrup from sugar crystals in a revolving centrifugal basket which comprises providing a supply of superheated water under pressure at a temperature between about 225 and 250°F., releasing the pressure and leading the water to a spray nozzle located inside the revolving basket, and spraying into the charge in the basket a resulting hot mist of superheated water and steam.

Continuous Liming and Carbonatation of Juices. HENRY A. BENNING, of Ogden, Utah, U.S.A. 2,236,419. March 25th, 1941.—Apparatus for the continuous liming and carbonatation of sugar juices comprising a tank for holding a mixture of raw juices and previously carbonatated juice, means for supplying a CO_2-bearing gas to said tank, an annular chamber surrounding said tank and constituting a mixing chamber, a substantially horizontal perforate partition dividing said chamber into a plurality of superposed sections, an upper one of said sections being in communication with said tank through an annularly arranged series of ports, a conduit leading from the lower portion of said tank and terminating in a substantially horizontal discharge portion in a lower one of said sections whereby previously carbonatated juice is conducted to said chamber and introduced thereinto in a substantially circumferential flow, means associated with the perforations in said partition for assisting in maintaining the circumferential flow as material from a lower of said sections passes through said perforations to an upper of said sections, means for adding raw juice to previously carbonatated juice conducted to said chamber from said tank, means to introduce lime into the resulting mixture of said juices, and means for discharging carbonatated juice from the apparatus.

Fertilizer Manufacture. KAI PETERSEN, of Soborg, near Copenhagen, Denmark. 2,241,734. May 13th, 1941.—Claim is made here for a method of producing fertilizers comprising supplying organic waste materials to a cylindrical container in a finely divided state with water, mechanically rotating the container, passing air over the material to promote the growth of the aerobic bacteria thereby effecting a biological decomposition (mineralization and nitrification), and continuing the described mode of operation for a few hours, therby producing a mass in which the aerobic bacteria are present in a high concentration, the material thus resulting having a high fertilizing value.

Recovery of Sugar from Beet Molasses. ROY H. COTTRELL and VERNAL JENSEN, of Ogden, Utah, U.S.A. 2,239,082. April, 22nd 1941. Claim 1.—In a method of recovering sucrose from beet molasses, the steps of adding lime within 5 to 12°C. to precipitate calcium saccharate, adding sludge obtained from a subsequent step containing hot calcium saccharate precipitate, filtering the resulting mixture while within 30 to 35°C. to obtain cake containing hot and cold calcium saccharate precipitates, heating the filtrate to precipitate hot calcium saccharate, treating the resulting mixture to separate the same into a sludge containing the hot calcium saccharate precipitate and a substantially clear hot waste liquor, and adding said sludge to the mixture of cold calcium saccharate precipitate and cold mother-liquor in a previous step of the method.

Use of Colloidal Gel for Purification. PIERCE M. TRAVIS (assignor to JACQUES WOLF & Co., of Passaic, N.J.). 2,220,667. November 5th, 1940.—Claim is made for the method of purifying a solution of incompletely refined sugar which consists in adding to the said solution a small quantity of a colloidal gel comprising a composite gel having approximately the following composition on a dry basis: calcium phosphate, 70 to 90 per cent.; calcium silicate, 2 to 10 per cent.; and aluminium hydroxide, 2 to 12 per cent.

UNITED KINGDOM.

Syrup for Stabilizing Food Products.[1] JOHN J. NAUGLE, of 120, Wall Street, New York. 533,258. October 24th, 1939.—Claim is made for the preparation of a stock stabilizer for imparting the proper body and texture in the manufacture of certain food products (ice cream, cheese, etc.), consisting in the extraction of the soluble gums from Irish moss, adding an activated carbon as a filtering agent, adding sugar to the mixture of extract and filtering agent, and finally filtering to obtain a deodorized, deflavorized and decolorized syrup. Amount of sugar added may be such as to obtain a mixture having a density of about 67° Brix, and containing from 0·2 to 1·0 per cent. of the soluble extractive matter, based on the weight of the sugar solids. In extracting the soluble gums from the Irish moss, it is soaked first in water, and then boiled in a sugar solution to obtain an extract to which the activated carbon is added. After adding the carbon, the *pH* value of the extract may be adjusted to a reading of 7·0 to 8·0 *pH* to break the bond between the filtering agent and the gums in the extract, after which filtration is carried out, and the sugar lastly added to the filtrate.

1 See also U.S. Patent, 2,188,597; *I.S.J.*, 1940, p. 117.

Stock Exchange Quotations of Sugar Company Shares.

LONDON.

Company.	Quotation July 21st 1941.		Quotation June 20th 1941.		1941 Dealings Highest. — Lowest.
Anglo-Ceylon & General Estates Co. (Ord. Stock) ..	24/0 — 25/6	..	24/0 — 25/6	..	25/3 — 24/3
Antigua Sugar Factory Ltd. (£1 Shares)	$\frac{3}{8}$ — $\frac{5}{8}$	..	$\frac{3}{8}$ — $\frac{5}{8}$	..	11/3 — 8/9
Booker Bros., McConnell & Co. Ltd. (£1 Shares)....	$2\frac{3}{8}$ — $2\frac{5}{8}$	..	$2\frac{3}{8}$ — $2\frac{5}{8}$	..	52/6 — 47/6
Caroni Ltd. (2/0 Ord. Shares)	1/0 — 1/6	..	1/0 — 1/6	..	1/2$\frac{3}{4}$ — 11$\frac{1}{4}$
(6% Cum. Pref. £1 Shares)	21/9 — 22/9	..	21/9 — 22/9	..	22/6 — 20/3
Gledhow-Chaka's Kraal Sugar Co. Ltd. (£1 Shares)..	$1\frac{3}{16}$ — $1\frac{5}{16}$	..	$1\frac{3}{16}$ — $1\frac{5}{16}$	..	24/6 — 22/0
Hulett, Sir J. L. & Sons Ltd. (£1 Shares)	25/9 — 26/9	..	25/3 — 26/3	..	26/7$\frac{1}{2}$ — 22/1$\frac{1}{2}$
Incomati Estates Ltd. (£1 Shares)	$\frac{3}{16}$ — $\frac{5}{16}$	..	$\frac{3}{16}$ — $\frac{5}{16}$	..	3/10$\frac{1}{2}$ — 3/10$\frac{1}{2}$
Leach's Argentine Estates Ltd. (10/0 units of Stock)	5/9 — 6/3	..	5/0 — 6/0	..	6/6 — 5/0
Reynolds Bros. Ltd. (£1 Shares)	36/0 — 37/0	..	34/6 — 36/6	..	38/0 — 32/7$\frac{1}{2}$
St. Kitts (London) Sugar Factory Ltd. (£1 Shares) ..	$1\frac{5}{8}$ — $1\frac{7}{8}$	..	$1\frac{5}{8}$ — $1\frac{7}{8}$	..	35/0 — 34/3
Ste. Madeleine Sugar Co. Ltd. (Ordinary Stock)	13/6 — 14/6	..	13/0 — 14/0	..	14/3 — 11/9
Sena Sugar Estates Ltd. (10/0 Shares)	5/9 xd 6/3	..	3/9 — 4/9	..	6/1$\frac{1}{2}$ — 4/0
Tate & Lyle Ltd. (£1 Shares)	53/3 — 54/3	..	$2\frac{5}{8}$ — $2\frac{11}{16}$	..	54/6 — 46/0
Trinidad Sugar Estates Ltd. (Ord 5/0 units of Stock)	5/3 — 6/3	..	5/3 — 6/3	..	5/7$\frac{1}{2}$ — 5/0
United Molasses Co. Ltd. (6/8d. units of Stock)	24/4$\frac{1}{2}$ — 24/10$\frac{1}{2}$	..	24/4$\frac{1}{2}$ — 24/10$\frac{1}{2}$	..	25/1$\frac{1}{2}$ — 21/9

NEW YORK (Common Shares).†

Name of Stock	Par Value.		Closing Price June 30th, 1941.		1941. Highest for the Year.		Lowest for the Year
American Crystal Sugar Co.	No par	....	$16\frac{1}{4}$	..	$17\frac{1}{4}$	..	$9\frac{1}{2}$
American Sugar Refining Co.	$100	....	$16\frac{1}{4}$	..	19	..	13
Central Aguirre Associates	No par	....	16	..	$22\frac{3}{4}$	..	$15\frac{1}{2}$
Cuban American Sugar Co.	$10	....	$4\frac{3}{4}$	..	$5\frac{1}{4}$	..	$3\frac{1}{2}$
Great Western Sugar Co.	No par	....	$24\frac{3}{8}$	..	$26\frac{3}{8}$	..	$19\frac{7}{8}$
South Puerto Rico Sugar Co.	No par	....	$14\frac{1}{4}$	..	21	..	13

† Quotations are in American dollars and fractions thereof.

United States, All Ports.

(Willett & Gray)

	1941 Long Tons		1940 Long Tons		1939 Long Tons
Total Receipts, January 1st to June 7th	2,367,834	....	1,813,119	....	1,865,090
Meltings by Refiners ,, ,, ...	2,026,997	....	1,677,646	....	1,698,136
Importers' Stock, June 7th	130,814	....	79,972	....	44,494
Refiners' Stock ,, ,, ...	476,718	....	492,070	....	322,442
Total Stock ,, ,, ...	607,532	....	572,042	....	366,936
	1940		1939		1938
Total Consumption for twelve months	5,712,587	....	5,648,513	....	5,604,051

Cuba.

(Willett & Gray)

	1941 Spanish Tons.		1940 Spanish Tons.		1939 Spanish Tons
Carry-over from previous crops	1,184,393	....	588,293	....	729,172
Less Sugar for Conversion to Molasses	71,105	....	— —	....	— —
	1,113,288	....	588,293	....	729,172
Production to June 7th	2,400,000	....	2,753,903	....	2,696,517
	3,513,288	....	3,342,196	....	3,425,689
Exports since January 1st	1,381,794	....	1,173,330	....	1,228,914
Stock (entire Island) June 7th	2,131,494	....	2,168,866	....	2,196,775

Grinding Ended

Correspondence.

Evaluation of Cane Varieties in South Africa.

To The Editor,
"The International Sugar Journal."

Dear Sir,

I am directed by the Executive Committee of the Natal Sugar Millers' Association to write to you in regard to the article "Evaluation of Cane Varieties in South Africa" by Messrs. G. M. Coates and V. M. Hinchy, which was published in the January issue of your Journal.

It is considered that readers of the article, who are not conversant with the actual position, might be led to believe that the method of evaluation employed had in fact been adopted by the Sugar Industry in South Africa, and the object of this letter is to correct any such impression.

The position is that in terms of our Sugar Industry Agreement an Enquiry had been held to determine the Additional Milling Value, if any, of non-Uba canes, and the article which you published was merely a précis of the representations made at that Enquiry on behalf of the Cane Growers.

The proceedings at the Enquiry were very protracted; they commenced on the 1st April, 1940 and only ended on the 4th March, 1941, when the Adjudicator made his award.

Translated into the same terms as those quoted in the final figures of the article, the "actual additional value per ton of each variety," as awarded by the Adjudicator is as follows;—

POJ	Co 281	Co 290	Co 301
7·95d.	6·83d.	3·55d.	3·31d.

It will be appreciated if you will publish this letter so that any wrong impressions which may have been created by the article may be corrected.

Yours faithfully,

J. D. Cunningham,

Natal Sugar Millers' Association. *Secretary*.
Durban. 21st May, 1941.

*** We readily publish this disclaimer; but would explain that the paper in question was published by us as an interesting contribution to the subject without any intention of taking sides in a controversy seemingly requiring an Adjudicator's award to settle. In any case, the footnote to the authors' names made it clear that the paper was contributed by members of the South African Cane Growers' Association. It was a pure coincidence so far as we were concerned that the article published in our January issue appeared on the eve of the Adjudicator's statement of award.

Brevities.

U.S. Quotas for 1941.—Another revision of the U.S. quotas, as fixed by the Department of Agriculture, was announced on June 9th, showing a further increase in the total, this time by 273,672 short tons, making the figure 7,125,561 short tons, as compared with the 6,851,889 tons announced on March 19th. The initial quota, established on December 7th last, was 6,616,817 tons. Cuba gets an increase of 78,283 tons, Domestic Beets one of 63,471 tons, Philippine Islands 42,173 tons, Hawaii 38,413 tons, Puerto Rico 32,678 tons and Domestic Cane 17,206 tons. Willett & Gray observe that the increased allowance for 1941 works out almost exactly at the 4·624 per cent. average yearly increase in consumption over the last 118 years as recorded by them, but no such increase in consumption in any one year has been actually shown since 1929.

Cuban Molasses.—Exports in 1940 from Cuba to the U.S. comprised 146,954,461 galls. of blackstrap, of which 134,680,946 went to the U.S., and the remainder to the U.K. and Canada; also 168,839,183 galls. of rich invert molasses, of which 110,415,920 went to the U.S. and 58,034,913 to the U.K. and 388,350 to Canada. Nearly 8 million galls. of invert syrup were exported, practically all of it going to the U.S. A figure of 9 lbs. of sugar to a gallon (U.S.) of high-test molasses or syrup is generally accepted in calculations relating to this material.

Java Exports, 1940-41.—Exports of sugar from Java during the crop year ended March 30th last totalled 837,342 long tons, according to Lamborn, as against 1,214,125 tons in 1939-40, a decrease of 376,783 tons or a little over 31 per cent. This represents the smallest shipments in 38 years. In consequence, the carry-over on April 1st was 628,703 tons, an increase of 390,527 tons compared with April 1st, 1940. The peak carry-over was that in 1933 when 2,492,622 tons of sugar was in hand. Sugar production for 1940-41 totalled 1,579,697 long tons. For 1941-42 a crop of 1,722,350 tons has been decreed by the local government.

"Luxovit."—This is a German artificial honey preparation containing vitamins. A saturated sugar solution is heated up to 50 to 55°C. with de-bittered yeast, when the sucrose present is inverted without the destruction of the cell contents, which are rich in vitamins. About 10 per cent. of this liquor is mixed with 90 per cent. of an ordinary inverted syrup, and the product marketed under the name of "Luxovit." It is a clear brown, opaque syrup, smelling somewhat of yeast, very sweet, and with a mildly acid taste. It contains enough invertase to effect inversion, making it a useful product to confectioners. Use of such preparation is being encouraged in Germany to make the war-time bread more palatable.

Late F. R. Bachler.—This well-known American chemist died recently in Oxnard, Cal., at the age of 62. In his earlier days, he had worked in Louisiana, where he had conducted experiments on the use of colloidal clays for clarification;[2] but was better known on the beet side of the industry. He began in 1915 as chemist to the Oxnard b.s.f., and in 1934 was made supervising chemist to the group of eight factories belonging to the American Crystal Sugar Co. He invented a double eye-piece for the polariscope for the simultaneous use of two observers; he devised the one-solution method of analysing sugar products; and he experimented with zeolites for removing potash and other salts from molasses. He also patented several processes for clarifying sugar solutions.

[1] *Deut. Zuckerind.*, 49, No. 2, pp. 64-65.

[2] U.S. Patent, 1,170,868.

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Notes and Comments.

The Churchill-Roosevelt Declaration.

It has more than once been rumoured during the past summer that Hitler's Government meant one of these days to stage a peace offensive based on the New Order he is establishing in Europe, in the hope that this would impress neutrals and give him a better chance to remain in possession of his gains. His argument would undoubtedly be that as Europe is now under one control it should be left as an entity, and that further attempts to break it up would be so much aggressive action on the part of the Allies.

It was well, then, that Mr. CHURCHILL and President ROOSEVELT should arrange a venturous meeting somewhere in the Western Atlantic and draw up a number of points covering future intentions so as to nip this projected German propaganda in the bud. These points embrace "certain common principles in the national policies of their respective countries [Britain and America] on which they base their hopes for a better future for the world." Briefly put, these declare that (1) the two countries seek no aggrandisement, territorial or otherwise; (2) they desire to see no territorial changes that do not accord with the freely expressed wishes of the peoples concerned; (3) they respect the right of all peoples to choose the form of Government under which they will live, and wish to see self-government restored to those who have been forcibly deprived of it; (4) they will endeavour to further the enjoyment of all countries, victor or vanquished, of access, on equal terms, to the trade and the raw materials of the world; (5) they desire to bring about fullest collaboration between all nations in the economic field, so as to secure improved labour standards, economic advancement and social security; (6) they hope after the final destruction of Nazi tyranny to see established a peace which will afford safety to nations and an assurance that all the men in all the lands may live out their lives in freedom from fear and want; (7) such a peace should enable all men to traverse the high seas and oceans without hindrance; (8) they believe all of the nations of the world, for realistic as well as for spiritual reasons, must come to the abandonment of the use of force. Pending the establishment of a wider and permanent system of security, they believe that the disarmament of aggressive nations is a first essential. They will likewise aid and encourage all practicable measures to lighten the crushing burden of armament for all peace-loving peoples.

This momentous declaration of the aims of the leaders of the two greatest democratic countries of the world in continuing to a successful issue the struggle against the Nazi tyranny must dispose of the last shreds of the insinuation fostered by the Hitler clique that the Allies by continuing the war have aggressive intentions. Not that the Allied peoples ever thought so, but their aims, and those of the United States in the process of assisting them, needed crystallizing as a counterblast to the attempts of the Germans to secure control of yet further countries of the world. The world States that are still neutral, which includes all South and Central America, will now know where they stand, in the matter of choice of ideologies, and it is hard to believe that they will prefer a Nazi-ordered world to living under the principles of the above eight points.

Some neutrals have observed that this declaration is anticipating events and that the war has first to be won. But this is a matter of continuing or fresh strategy and tactics, and though it may be assumed that the two leaders who met at the *rendez-vous* in a sheltered harbour somewhere in the Atlantic went very thoroughly into this aspect in the course of their conversations, they have no wish to enlighten the enemy as to their intentions on that score. But the presence at the now historic meeting of high-ranking officers of the respective countries' naval, military and air forces suggests that the immediate task of winning the war was very much a subject of debate and of decisions come to. But only time will show what was actually planned. Nothing is said to suggest that the President has committed his country

more definitely to entering the war as a combatant, and it seems likely that any such decision must defer as before to a policy of "gradualness," dictated by the need to secure in course of some further time the unanimous backing of all that counts in American politics. The fact that Congress the other day passed the Bill for extending the time of service of army conscripts by only one vote suggests that American public opinion still harbours an extreme reluctance to adopting military measures as a means of defence against more distant dangers to their country. But the problem of assisting with materials the efforts of the European allies has long since passed the stage of hesitation, and we are told that at this sea conference the whole question was further examined, with results which will probably reveal in due course a further intensity of effort. The needs of the Soviet Union in the matter of supplies were also not overlooked.

The War.

Russia's determined resistance to the vast German efforts to encompass the destruction of her armies and seize her leading cities has shown no slackening in the past month, and after some nine weeks of intensive fighting the Germans are little nearer their goal, save in the Ukraine where the Nazi divisions have succeeded in overrunning the country to the vast curve of the Dnieper river and have isolated Odessa. But Leningrad, Moscow and even Kiev are still safely in Russian hands, and though the German line has slowly encroached nearer these cities, the latter seem in no immediate danger and, save perhaps Kiev, may well hold out till the approach of winter makes any major operations difficult, as they are said to be well fortified. In the Ukraine, however, the German armies have undoubtedly scored a victory over the Russian defence and have succeeded in overrunning more than half that province. But at the time of writing it seems fairly clear that they have not been successful in destroying Marshal BUDYONNY's southern Soviet army which was their primary aim. Most of the latter force has effected a more or less orderly retreat over the Dnieper and as this river is some 700 yards wide in its lower reaches and is fringed by marshes it forms a line of defence not easily passed. The Germans have now reached some of the industrial regions of the Ukraine. They have, however, much further to go before they can turn south to approach the Russian oil regions and in the final stage would have to cross the vast Caucasus range of mountains, the defence of which may offer considerable possibilities for the Russians.

These German gains have not been effected without huge losses in men and material to both sides, but it may be assumed from the nature of the fighting that the invaders have suffered the most. Russian estimates of German losses in the field are mounting up to the two-million mark. Russian losses are more a matter of conjecture, for the Soviets are naturally silent on that score, only reporting the respective losses of aircraft, and German figures are invariably suspect from considerations of the propaganda they excel in.[1] But the Russians have the greater reserves of manpower from all accounts ; only their ability to equip it in time is the unknown factor. So far there is little or no indication to suggest that they are near the end of their reserve resources, and their air force is still aggressively active. The drain on German material has undoubtedly been very heavy and will increase as the Nazis penetrate further from their home bases. And Russian tactics of guerrilla warfare behind the German lines persist wherever the terrain allows, and are a serious factor for German supply services.

The next very few weeks will probably prove decisive in settling whether Germany can accomplish her task in Russia before winter comes or whether she will have to admit a serious setback to her plans and the need to dig in along a 1500-mile front for months to come till the spring provides opportunities, if any, for further advances into the heart of Soviet territory. The probability seems already writ large that the Nazis will fail to secure any tangible results in the remaining short time during which the going is good. But in that event there will be no Hindenburg line to hold the Russians in check and it seems unlikely that the latter, unless they are more exhausted than is supposed, will be content to pass the interval in trench warfare when the terrain is familiar to them and they are the more accustomed of the two to winter movement. So a campaign of winter attrition seems the least to expect and is quite in keeping with the Russian character. Meanwhile it is emphasized that a German setback in Russia just now will not exhaust the Nazi powers to strike in other directions during the winter, and the Allies must not relax their efforts to maintain their firm hold in other quarters. The Mediterranean and Spain are likely danger points, and Vichy is increasingly treacherous in policy. And there is Japan who seems hovering on the brink of decision to start major hostilities in the Far East, in the belief that the auspices will never be more favourable for territorial acquisitions than they are now, when the Russians in their north and the British in the south are unable to bring to bear their full forces because of commitments in Europe. Fortunately America is also vitally interested in the Far Eastern *status quo*.

German Strategy.

Some insight into German strategical plans for the past summer which seemingly came to nought has lately been revealed and indicates how nearly the

1 German figures of enemy losses are often correct when they are winning, but are usually doctored when things are not going so well with their operations.

present position of the Allied combatants in the Middle East was jeopardized at a time when the Allies were much less well placed to withstand a pincer movement on their hold of Egypt. When at the beginning of April Jugoslavia revolted against its quislings and attempted to form a firm front against Germany, the German overrunning of the country which speedily followed seemed yet another instance of the futility of small countries resisting the German might. But General SIMOVITCH, the Prime Minister of Jugoslavia, now claims that his country in taking up that attitude made a solid contribution to the failure of German plans to overrun both the Ukraine and Turkey in a pincer movement at just that date, the object being to seize the Russian oil wells in the Caucasus, as well as to advance on Egypt from Libya and through Turkey and Syria. The sudden defection of a neutral country on the German flank, as Jugoslavia was deemed to be, upset those plans and, instead, the Nazis had to invade first Jugoslavia and then Greece and finally Crete—operations which delayed the original plans so long that the British had time to suppress the premature Iraq rebellion and turn the German "tourists" out of Syria. As a consequence the Germans abandoned, for the time at any rate, the invasion of the Caucasus from the south and substituted a frontal attack on Russia which, as all the world knows, has not gone according to plan and has seriously depleted the German supplies of oil, while so far the road to Baku and Batum has not been opened, the Germans losing instead such oil stocks in Rumania as the Russian bombers have managed to destroy.

If the Germans fail in their present drive through the Ukraine some observers think they will yet attempt in the near future the southern passage through Turkey. But now that Syria is in Allied hands the R.A.F. would be in a better position to go to Turkey's aid and the British Middle East forces would also be a danger to the German flank. The German strength in Libya remains to be seen, but it is probably appreciable.

In respect to the Battle of the Atlantic, there is little news to go on, but all indications are that the German hold on those waters both by air and under the sea is undergoing a steady setback. British shipping losses are now published only intermittently but are said to be appreciably less of late weeks; whereas the tale of German and German-controlled shipping losses is becoming formidable. In five weeks to about the middle of August the enemy had lost by capture, scuttling or sinking approximately 606,000 tons of merchant shipping, this figure including the Russian contribution; and the total since the war began is put at about four million tons. At this rate the Germans may live to regret that they ever initiated a policy of ruthless sinkings, since the Allies now perforce follow suit, and their bag is only limited by the fewer opportunities that present themselves.

Trinidad College of Tropical Agriculture.

The annual report of the Imperial College of Tropical Agriculture in Trinidad for 1940 states that throughout the year the activities of the College were satisfactorily maintained, the number of scholars and students in residence at the end of the year being 57—a figure which has only once been exceeded. This is gratifying since the research work at the College, affecting mainly cacao, sugar and fruit, has an important bearing on food supply, and the training given to agricultural scholars by arrangement with the Colonial Office affords a safeguard against a recurrence of the shortage of specialist officers which the Colonial Empire experienced after the 1914-18 war.

Of the 57 students in residence, over 30 were taking the Diploma course and 19 the Associate course, while 7 were engaged on the Third Year Sugar Technology course. The Diploma students came mostly from the B.W.I. but there were also men from Columbia, Venezuela and Hong Kong. The Associateship students were mostly Colonial Office scholars.

As the value of the training given by the College in sugar technology has become more widely known, there has been an increasing demand by employers for College men trained in this science. And this demand seems now to be producing in turn a supply of students who wish to take the training. Previously, only two or three students each year after completing their preliminary two years in the Agriculture Diploma course elected to branch off into sugar technology; but in the current year there are seven students so engaged, of whom five are destined for the West Indies. As a consequence, a new separate building is becoming urgently needed for the sugar technology department, so that adequate laboratory accommodation can exist for the succession of first and second year students that promises to arrive in the next few years. Such an addition to the existing buildings would relieve the present strain on the chemical department where at present sugar technology work is conducted.

Research work in sugar technology, first started in 1938-39, proceeded very satisfactorily during 1940. Meetings were held with the Chemists and Engineers of Trinidad sugar factories at which previous season's research work was discussed and apposite criticisms and very useful constructive suggestions were offered, to the benefit of the College training course. Such discussions have shown how much the technology of sugar lacks a basis of systematic scientific investigation and how great, therefore, are the opportunities for further improvements of the factory processes through such study. Unfortunately the cost of travel, both in time and money, militates against any large attendance from other parts of the West Indies at such meetings. The College technologists have had to do what they could by travelling to make contact

with the industry in all the West Indian colonies. Mr. DAVIES has suggested to the Sugar Manufacturers' Associations of Jamaica and of Barbados that they should each employ a technologist of their own to form a link between the College research department and their various separate factories, to interpret results to the (usually non-technical) managers of the factories, and to act as their technical advisers generally. Such technical advisers to groups of small factories should have no difficulty in bringing about economies and improvements in efficiency of a financial and readily calculable value far in excess of the cost of their services. It is naturally difficult for the smaller factories to keep fully up-to-date without continuous technical assistance.

Colonial Sugar Refining Company.

At the annual meeting for the year ended March 31st, 1941, of the Colonial Sugar Refining Company, the Chairman (Mr. E. R. KNOX) gave his usual survey of the position of the Australian sugar industry and of his company's share in its prosperity. The record Australian production of some 900,000 tons in 1939 was not repeated in 1940 owing to the incidence of floods and cyclones, falling in fact to 783,000 tons. The 1941 crop is forecast at 830,000 tons, but the shipping and storage difficulties which are threatening may prevent the manufacture into sugar of part of that crop. Fortunately, all the sugar of the 1940 season was expected to be removed from Australia before the succeeding crop commenced, in spite of the existing shortage of shipping. At the Company's mills 164,208 tons of sugar were produced in Australia in 1940 and 118,463 tons in Fiji. All the export sugar continues to be sold to the British Ministry of Food.

The Company's new distillery at Melbourne was completed during 1940 and has worked satisfactorily. Additional molasses was bought in Queensland last year for producing power alcohol, for which there is a ready market, and this year the amount of molasses required for this purpose will be still greater and has necessitated the purchase of a tanker for carriage of molasses in bulk.

The C.S.R.C. has endeavoured to bear its share of the national war effort. Three factories have been constructed, all at the Company's own expense, for the purpose of producing war material and, as well, a large amount of war work is being carried out in their general workshops. This production of munitions is being done either as a gift or without any profit to the company.

Trends in the U.S. Sugar Industry.

Some trends in the distribution of sugar in the United States have recently been analysed by the Bureau of Census of the Department of Commerce and published in a service paper.[1] From this one gathers that a predominant trend since 1929 has been for refiners of both beet and cane sugars to maintain close contact with industrial consumers, although wholesalers and jobbers continue as leading factors in the actual distribution. With cane sugar refiners a tendency to increase factory sales branches is noted, but sales direct from refineries have shown little change during recent census periods.

In the distribution of beet sugar approximately three-fourths of that produced in the States in 1939 was sold direct from refineries to wholesalers and jobbers. Sales to industrial users, e.g., confectionery manufacturers, amounted to 13·5 per cent., while sales direct to retailers accounted for 6·9 per cent. Compared with 1929 and 1935 it is significant to note that although wholesalers and jobbers continue to be the predominant channel for beet sugar, a gradual decrease is taking place (from 93·9 per cent. in 1929 to 76·7 in 1939). In contrast, sales to users increased in the same period from 6·1 to 13·7 per cent., showing a tendency on the part of the sugar manufacturer to deal more directly with the industrial user. The proportion of the total output sold to retailers for re-sale has remained at approximately the same level as in 1935. Sales direct to households came to 2·7 per cent. Brokers handled 84 per cent. of the total value of the sugar produced.

In respect to cane sugar, approximately 38·3 per cent. of the quantity refined was sold from plants to wholesalers and jobbers, while 31·7 per cent. was marketed by selling organizations owned and operated by the refiners, and 13·5 per cent. was sold to retailers. In addition, 15·3 per cent. was sold direct to industrial users. No sales to households are recorded. Nearly 67 per cent. of the total cane sugar distribution was handled by the brokers. Compared with 1929 and 1935 increases are noted in sales by refineries through their own sales branches —31·7 per cent. of the total output, compared with 24·9 in 1935 and 26·1 per cent. in 1929, indicating a possible tendency by the refiners to establish selling branches of their own. Sales direct to industrial users have increased from 8·5 per cent. in 1929 to 15·3 in 1939. A gradual decrease is noted in sales (inland and export) to wholesalers and jobbers—from 53·3 per cent. in 1929 to 39·5 per cent. in 1939.

The cane sugar refining industry in the United States consists of 27 plants, but the seven leading cane sugar refining corporations account for 71·1 per cent. of the total value of sugar produced. The combined net income in 1939, before deduction of interest on long-term borrowings and of income taxes, on the average total capital employed by these corporations in their cane sugar refining operations was 3·6 per cent. The rates of return for individual corporations ranged from a loss of 3·9 per cent. to a profit of 9·8 per cent. Three of the seven had rates higher than the average.

[1] Industrial Reference Service, Part 3, No. 42.

The Louisiana Cane Farm.

The system under which cane is grown in Louisiana is conditioned by the history of the industry. In the passage from the primitive life of the early settlers as hunters and traders to a settled life on the land, experiments were made with various crops of which tobacco and indigo were the most important, the latter promising to become the staple crop. It fell from favour towards the end of the eighteenth century through disease, low prices and injurious effect on the health of the slaves, a rather curious reason in view of Indian experience where the labourers appeared to derive a beneficial effect, particularly on the skin, from contact with the fermenting extract in the process of beating the liquor. It was to sugar cane, first introduced in 1751 but with small success owing to failure to produce a well-granulated product, that attention was turned in 1794. From then on the cultivation of cane became an established industry which still survives in spite of many vicissitudes. Of these the most devastating was the civil war when the output of sugar fell from 264,159 tons in 1861 to 5971 tons in 1864. Fiscal policy and disease have also, at times, had their repercussions.

The civil war, with the abolition of slavery, shook the very foundations of the industry which was forced to adapt itself to the conditions involving a paid labour force. The reaction was directed to the employment wherever possible of machinery. About the same time a revolution was taking place in the processes of manufacture. Power units for grinding and the work of the factory, the vacuum pan and, in fact, all those changes which have led to the development of the modern central, were in process of evolution. In 1880, when the output of sugar had recovered to 136,512 tons, this quantity was the product of 1144 small mills. In 1880 there were 273 factories grinding by horse power and all were eliminated by 1905.

This early history, here summed up in a few words, together with an account of later developments particularly on the technological side, was recounted by C. A. Browne in a paper entitled "The Development of the Sugar Cane Industry in Louisiana and the Southern States" at the Sixth Congress of the International Society of Sugar Cane Technologists in 1938. The technical developments both in factory and field, however, find their counterpart in other cane growing countries; they are, in fact, world-wide reactions to progress. Louisiana shows other reactions which can be directly traced to the civil war and they concern the economy of the estate as it has adapted itself to the conditions imposed by the change over from slave to free, paid labour. Concurrent changes in the factory which have led to the development of the large central as the most economic unit have not been without influence and the result is a somewhat bewildering variety in the systems under which cane is grown.

In addition to this variety of systems, rather underlying it, is the irregular distribution of the crop While of the total crop acreage of the State only 6·6 per cent. is under cane, this figure for the 20 sugar parishes is 18·6, while there is a wide variation between the different parishes. Thus, in St. Mary parish, 51·7 per cent. of the cropped acreage is under sugar cane; Assumption, Iberia, Iberville and St. John all have over 40 per cent. and W. Baton Rouge 39·4 per cent. At the other extreme Avoyelles has 4·7, Rapides 4·4, E. Baton Rouge 2·2 and St. Landry only 2·1 per cent. Broadly speaking, cotton takes the place of sugar cane in those parishes in which the acreage under cane is low.

When attention is directed from these broad differences to those which concern the individual units, the complexity of the economic conditions under which cane is grown becomes even more apparent. Using the term "operator" in the sense of the worker of the unit, whether landlord or tenant, more than a quarter of the operators grow two acres or less, approximately half grow ten acres or less and only nine per cent. over 20 acres. Yet that fourth grow only two per cent. of the total acreage and that nine per cent. 75 per cent. The reason is that there exist a number of units which grow over 1000 and even 2000 acres. There appears here a valuable opportunity for securing data on the relative efficiency of small and large scale units. A commencement of such a study is recorded in a series of Bulletins recently issued by the Agricultural Stations of the Louisiana State University.[1]

The last of these considers 100 farms distributed over nine parishes and excludes farms growing less than 30 acres, farms, that is, which may be termed family farms, and the chief object of the study is the labour and tenancy relations. Some one-third of the sample had below 50 and another third over 100 acres with five of 500 to 999 acres and four over 1000. It occupies, therefore, a middle position between the first two.

The essential difference between these farms and the family farm lies in organization of the labour supply. For the most part, that is, some 77 per cent. of the total cane acreage, is worked by wage labour; a further 20 per cent. is worked on a share tenant system and a little more than three per cent. by that most primitive of share systems, share cropping, a system adapted to the poorest class of field worker who provides only labour in return for a share in the crop. In only one parish, and then only to the

[1] *Farm Management and Cost Study on 500 Family-sized Farms in the Louisiana Sugar Cane Area*, Bull. 314, 1940. *Financial Results of Large Sugar Cane Farms in Louisiana*, Bull. 315, 1940. *The Sugar Cane Farm*, Bull. 320, 1940.

extent of 13 acres, is a cash tenant system adopted. Share croppers are found principally on the smaller sized farms while share tenants are mainly concentrated on the medium sized and, to a less extent, on the larger farms. Characteristic of the farms is that they are owner managed with the owner resident on the farm or near by; absenteeism is rare. A further point having bearing on the labour question is the fact that sugar cane, if the main, is not the only crop. Crops, in fact, occupy only some 47 per cent. of the total farm area with woods covering over 36 per cent. Of the cropped area 52·4 per cent. is under cane, with corn interplanted with soy bean occupying some 37 per cent. Soy beans, cotton and potatoes fill in the greater portion of the remaining area. Livestock plays an insignificant role.

As bearing on the labour question, too, is the degree of mechanization. Only two out of 34 farms under 50 acres of cane employ tractors, thereafter the tractor plays a more important role with one marked exception, that of a farm of over 1000 acres with no tractor. The explanation is that this farm is run entirely on a tenant basis.

Turning more directly to labour, much of this is resident, particularly on the larger farms, and it is of interest to note the divergence of opinion of the different operators as to the advantages or the reverse of residential labour. Better work is claimed by the advocates of each system as well as by those who favour share cropping. Actually 52 of the 60 farms worked by wage labour only, four of the 15 farms worked by share tenants, three of the five farms worked by share croppers and all the ten farms working both systems provided residences for the labour. As to the nature of the labour, it comes as a surprise to one not personally acquainted with the area, that some 45 per cent. of the labour is white. As might be expected, however, there is considerable variation in the percentage of whites in the different classes of labour. Among resident workers, this percentage is 40, among share tenants 73 while, among share croppers, that system which arose in succession to slavery particularly in the cotton tracts, it is 36.

There is, of course, a seasonal demand for labour which reaches its peak in December when it is some three times the demand of the slack months, July to September. The growth of several crops, however, tends to equalize the demand. It seems that the resident labour kept is commonly in excess of the minimum demand. Non-resident labour is mainly recruited locally but, especially on the larger farms, it may come from a distance, even another State, when it may be obtained through a contractor.

It will be sufficient only briefly to refer to the wage rates, as local standards differ so greatly from country to country. The daily rate for resident labour averages \$0·96; for cutting, \$1·38 for white and \$1·34 for coloured, these rates being slightly lower for non-residents. The yearly income of resident labour averages \$280 for the head of the family and \$365 for the unit family. Approximately half the cutting is done on piece work at a rate of \$0·64 per ton. In addition to the above, resident labour receives certain perquisities, house and garden, wood, farm and garden equipment and so on. The value of this is estimated at \$69 per annum by the operators and \$45 by the enumerators. Non-resident labour may receive as perquisites house or room, wood and, in a few cases, board. Resident labour may receive, too, short term loans which averaged \$120 per family.

Tenant labour is, as has been said, of comparatively small importance. With one exception, the lease is an oral agreement for one year with renewal unless particularly specified. Arrangements for tending the crop, provision of farm equipment and seed, mending the ditches and so on varied widely. The usual arrangement appears to be on a two-thirds, one-third basis.

The above forms a brief survey of the general conditions prevailing in the Louisiana sugar area. The second of the quoted Bulletins deals with the financial results secured under this general system on 33 farms in 1937 and 35 in 1938. Averaging as these do some 2200 acres under cultivation and 1400 acres under cane, they are definitely on the large side. In making this financial survey an initial difficulty arose from the fact that sugar cane, if the chief, is not the only crop grown. The cost of producing these other crops is, therefore, included in the general overhead costs and credit taken for the income derived from their sale. Of the total cost the outstanding single item is labour, some 52 to 55 per cent. of the total and divided between 15 to 17 per cent. overhead, 14 to 15 per cent. planting and cultivating and 23 to 24 per cent. harvesting. Interest at nearly 10 per cent. and estimated at 5 per cent. on total value of assets, is the next biggest single item though the sum of various items which can be grouped as materials, accounts for some 10 per cent. Income is to the extent of some 90 per cent. from cane, made up of 68 per cent. from sale of cane and 22 per cent. from Agricultural Adjustment Administration payments.

Seeing the mixed nature of the crops grown, an attempt is made to determine the effect of mixed cropping by collating the results on a basis of total cultivated area and of area under cane. Though there is a tendency for the smaller farms, those under 750 acres in cane, to broaden the range of crops grown, there is little difference in this respect, the cane acreage of farms with less than 750 acres under cane forming 56 per cent. of the total in 1937 and 60 per cent. in 1938 against 66 and 62 per cent. respectively for farms with between 750 and 1750 acres and 64 and 63 per cent. respectively for farms with over 1750 acres. There is a tendency for the

net operating income to decrease with size of farm while, after debiting interest, only the farms under 2000 acres cultivated and 1750 acres cane show a profit and then only in 1938. This economic advantage of the smaller farms is shown in another way by the fact that those farms disposing of more than 35,000 tons of cane showed a higher cost per ton of cane sold.

From an analysis of the financial returns on a basis of tons of cane per acre, it appears that only those farms giving the highest yield per acre showed a profit after debiting interest and then only in 1937; in fact, yield is the dominating factor. But yield is itself shown to be dependent on the size of the farm, the average size of the farms yielding under 22 tons, between 22 and 25 tons and over 25 tons per acre being respectively 6393, 4854 and 3763 acres. It is unfortunate, therefore, that the analysis is not carried a step further to indicate the degree to which tenancy in one form or another is adopted in the farms of the different sizes, though it is stated in the commencement that all these large scale farms are worked substantially on hired labour.

The first Bulletin deals with an entirely different type of farm, the family sized farm producing five or more acres of cane, ten or more acres of crops and deriving 50 per cent. or more of its income from cane. The average size of the 500 farms is 150 acres with 41 acres under cane and 45 acres under other crops. 38 per cent. were owner occupied, 26 per cent. part owned and part leased, the remainder leased.

Two methods are adopted for measuring costs; the "net cost," charging all costs to the main enterprise—in this case cane—and crediting subsidiary income, and "direct allocation," charging indirect expenses in proportion to use in the main enterprise. The latter is perhaps the more accurate but certainly the most difficult. Taking the first method, the average net cash cost was \$2·31 per ton cane and the income from sale of cane and A.A.A. payments \$3·68, leaving a profit of \$1·37 against which has to be set a valuation for operator's and family labour, rent, interest and depreciation, estimated at \$1·98. Even in these farms labour forms the outstanding cash charge at 39 per cent. of the total with the unpaid labour forming 16 per cent. A somewhat different picture is given by the direct allocation method. Cost of production per ton amounted to \$2·90 with income \$3·72 and of this \$1·40, or 48 per cent. is labour inclusive of operator's and family labour. The net profit on this basis is \$0·82 per ton of cane, against which must be set rent, interest and depreciation which, at the same figure as before, \$1·22 per ton of cane, leaves a loss of \$0·40 per ton.

It is not necessary here to follow the analyses of the charges other than labour, which are given in this Bulletin. It is pointed out that, in matters like these, averages have little value in determining the factors underlying success. In an attempt to determine the more important of these factors the five points, size of business (cultivated area), rates of production (yield per acre), choice of enterprises (proportion of cropped area under cane), labour efficiency and horse and machinery efficiency, are considered. The comparison is simplified since the price received for the product, cane, varied little and the A.A.A. payments were constant. For the purpose of this analysis farms were divided into those with less than 50 acres in crops and those with more, and each of these groups is further subdivided according to the yield, whether over or under 22 tons per acre, with a further subdivision according to the percentage, less than 35, between 35 and 45 and over 45, in cane. The analysis is made both by the net cost and direct allocation method and, as the conclusions are similar by both methods, the figures here quoted are those for net cost.

The first conclusion is that the larger the size of business the lower the cost. The small group of farms, averaging 30 acres in crops and 11 acres in cane, produced at \$115 per acre or \$5·40 per ton of cane, the corresponding figures for the large farms, which averaged 150 acres under crops and 68 acres under cane, being \$92 and \$4·10. Current cash costs, on the other hand, averaged \$2·24 for the small farms per ton and \$2·90 for the large farms.

In the matter of yield, the higher the yield per acre, the lower were the costs per ton. Of the small group the low yielding farms averaged 16·7 tons per acre with a cost of \$6·34 per ton; for the high yielding farms the respective figures were 27·0 tons and \$4·7. Figures of the same order were obtained in the case of farms forming the large group. The difference in this matter was such that the cost per ton on low-yielding small farms was about double that on high-yielding large farms. This is the case despite the fact that costs per acre increased on the high-yielding farms.

With regard to the third item, proportion of the cropped area under cane, the analysis shows that, for any particular size of farm and yield of cane, the cost per ton of cane decreased with a rising percentage of the area under cane. That, it would appear, is merely another way of stating that in 1938, the year for which the figures are quoted, cane was the most profitable of the crops grown.

The last figures to claim attention are those for crop-acres per man. On the small farms the figure for this measure is 16·10; on the large farms, 19·30. There is here evidence of greater labour efficiency on the large farms, tractors playing only a minor role, being owned on only 85 and hired on 55 of the 500 farms.

H. M. L.

Overhead Irrigation.

With its high labour costs and a considerable area of cane under irrigation, Hawaii has, more than any other cane growing country, reason to study closely ways and means for reducing the charges of this operation. There has, in fact, occurred a revolution in the methods of applying water to the crop, as references, too many to detail here, in the earlier issues of this Journal indicate. Contour lines, 10 and 20 ft. borders, straight long lines where the field slope is less than 3 per cent. and "herring bone" long lines where the slope is greater, with concrete flumes to check seepage and erosion, are some of the newer methods. These have resulted in greater labour and water efficiency, but all show certain defects. There is irregular vertical and lateral distribution of water from the long line, leading to progressively poor growth towards the tail, and root development is irregular. This is partially cured by slowing down the rate of water delivery which, however, results in an excessive loss by seepage. Again, ditches, flumes and irrigation pipes offer serious obstacles to mechanized cultivation. Under existing conditions, with adequate water and labour, the balance is in favour of the newer methods, but conditions may change and it is with this possibility in view that the Waialua plantation has experimented with overhead irrigation, of which an account was given by H. R. SHAW at the Third Annual Meeting of the Hawaiian Sugar Technologists.[1]

Overhead irrigation has been the subject of much study in the United States of America and has become an established practice for high priced crops, vegetable, nursery and citrus crops. Usually the installation is permanent with overhead perforated pipes or ground pipes with vertical rises carrying sprinklers at 40 to 50 ft. intervals. Such an installation costs some $300 per acre. In addition till recently sprinklers left much to be desired. But great strides have been made not only in the improvement of the efficiency of the sprinkler but in the construction of piping, with protective wrappings adding to its life, and of quick action couplings. Long lengths of lightweight, water-tight piping can, thus, be quickly erected and portable installations have become a possibility.

Overhead irrigation was first tried out in Hawaii on the Hawi Plantation in 1923. The main trouble in these trials lay in the sprinkler head and a home-made type was introduced, delivering 5½ galls. a minute under 38 lbs. pressure. Trials on the Ewa Plantation between 1925 and 1930 with this and the Orr, a commercial type of sprinkler, indicated that, given an improved sprinkler, overhead irrigation could compete with the furrow system, a significant gain of over 0·5 tons sugar per acre with better juices being recorded.

Waialua has, in recent years, suffered from a water shortage and, following difficulties experienced in long line irrigation, the opportunity was taken to experiment with the latest equipment for portable overhead irrigation. In 1936 sufficient equipment was obtained to try out the system on a 4-acre field of four-month-old cane laid out on the herring bone system. Though too small to give reliable comparative figures, the results were such as to encourage the extension of the experiment to a 106-acre field of rolling terrain with a general 7 per cent. slope. Of the two systems of obtaining a water supply under pressure, a portable motor-driven pump directly coupled to the portable system and drawing water from an open ditch along which it is moved, and a central pump with permanent pressure lines to which the portable laterals are connected, the latter was chosen as being the more economical. In the present case, the permanent supply lines were bedded 3 ft. deep along the main ridges and carried hydrants at 100 ft. intervals. The permanent piping used was spiral-weld, 12-gauge steel with 22½ lb. asbestos wrap with pipes 40 ft. in length. 1360 ft. of 8 in. and 6480 ft. of 6 in. piping was used; but these lengths are excessive owing to the shape of the field.

The pump, an Allis-Chalmers capable of delivering 1300 galls. per min. under 75 lbs. per sq. in. pressure, was sited near a supply channel from which a lead, doubly screened, led to a sump within the power house. The portable pipes were of 16-gauge galvanized iron in 20 ft. lengths with patented quick-coupling joint. Each pipe carries a ½ in. service outlet. Two types of sprinkler were used, the Rainbird Model 80 and the Buckner "Special Oversize." At nozzle pressures of 60 lbs. per sq. in. the radial throw of these is 70 ft. with, as the diagrams indicate, a very even scatter up to 50 ft. and a sharp decline above that distance.

The cost of the installation was $14,050 or $132·66 per acre—$90·11 on the permanent installation and $42·55 on the portable—which, on a 20-year life for the permanent, and a 10-year life for the portable, gives an annual charge on capital account of $8·75 per acre. The comparative cost of installing the herring-bone system is $3·49 per acre. Some $10 per acre per crop, either in saving in operating costs or in increased yield, is required if the system is to form a commercial proposition.

The operational costs are given in some detail and, for comparison, the plantation average figures for the two seasons, 1938 and 1939, are opposed. The comparisons are not, however, strictly accurate. Much of the operational work was of an experimental nature and it is more than probable that costs could be further reduced. They may be briefly noted, the comparable figures for 1938 and 1939 being bracketed.

[1] Reports, 3rd Meeting, Nov. 20, 1940, p. 31.

Ploughing.—Cost per acre $10·66 ($11·44 and $16·60). The major saving is on the provision of furrow banks no longer required.

Planting.—Cost per acre $23·24 ($31·99 and $27·13). Some experimental work in terracing to check erosion was included. Elimination of ditches, etc., led to an increased planted area of 3·34 acres. Here, undoubtedly, is a significant saving in planting.

Fertilization.—Cost per acre: fertilizer $32·23 ($31·19), application $0·84 ($2·50). In the first year the fertilizer was fed from hoppers tractor-drawn; in the second as a 28 per cent. solution fed to the sump at the rate of 10 lbs. fertilizer per min. giving a 0·1 per cent. solution in the system. Clear water was sprayed for 2 hrs. before, and 5·6 hrs. after fertilizer application for 1·5 hrs. The method proved very successful.

Cultivation.—Cost per acre-month $0·87 ($1·37 and $1·16). In man-days per acre the figure was 8·23 as compared with 15·58 for the surface irrigated area. The main economy lay in the lower weeding costs.

Irrigation.—Average performance in acres per man-day: first year 2·90, second year 3·14 (4 to 5 acres). The performance was necessarily limited by inexperience but any saving in labour appears to be unlikely. On the other hand, the better distribution of water limited the number of irrigations to 27·2 for the crop as against some 40 or more usually required with the long line. No obstacles, such as might be anticipated, were met with in moving the pipes and the labour expressed a preference for this work over irrigating herring-bone areas. Wind offered the greater problem. Normally sprinklers were set at 80 ft. intervals on pipes laid 100 ft. apart with a reduction of the spacing in windy weather. The sprinklers are set directly on the pipe for the first two months, on 4 ft. uprights from two to six months and subsequently on 8 ft. uprights. At 100 ft. × 100 ft. spacing the rate of application is equivalent to 0·34 acre-inches per hour.

Water conservation.—This resulted not only from the avoidance of seepage losses but from the above noted reduction in the number of irrigations. Loss by evaporation, though unmeasured, must be small compared with those from seepage. The total water supplied to the crop was 119·12 acre-inches as against 214·18 and 336·90 acre-inches for comparable fields. For tons sugar per million galls. water the figure obtained was 3·57 as against 1·88 and 1·32 for the same two cases.

Growth of the crop.—The mass of the area was planted to H 8965 with some 15 acres of H 109. Growth and stand were both satisfactory, more so in the case of H 8965 than H 109. Leaf colour and uniformity of stand were noticeably good and the feared spread of eye spot did not eventuate.

Harvest.—Trash percentage was relatively high at 12·02 per cent. and, under rather adverse weather conditions for the purpose, burning off was rather difficult. The yield of plant cane was 97·15 tons cane per acre, yielding 11·52 tons sugar. No direct comparison is available, the nearest being a field of H 109 yielding 81·2 tons cane and 7·49 tons sugar. The plantation average for the two years 1938 and 1939 is, for plant cane, cane 90·61 and 98·63 tons and sugar 11·27 tons and 12·47 tons.

Cane cutting was faster owing to the flat surface and averaged 15·12 tons per man. Track laying and haulage were also rendered easier.

Ratoon crop.—With no ditch or flume blocks, irrigation was commenced as soon as the portable tracks were lifted. The operations conducted included: replanting, which was heavy in the grab-harvested area, cost $36·91 per acre against $63·29 and $63·40 for the herring-bone, and early cultivation (tractor) with, as an experiment, a rotary brush weeder; two hand weedings; three sprayings; fertilizer application partly by machine and partly, as described above, in the irrigation water and a further cultivation.

Growth and stooling were excellent and the field, which had closed in by August 1 (the harvest was between February 17 and March 1), had, by the end of that month, a noteworthy appearance in spite of the dryness of that and the previous month.

Cost of ratoons.—Figures are only given up to the end of July. For the five months between the end of harvest to this date, the operations cost $36·91 per acre. Exactly comparable figures for the ordinary systems of irrigation are not available but fairly comparable figures are for the herring-bone system $63·29 and $63·40 and for the herring-bone cum long line $48·34 are quoted. These follow a total plant cane cost of $152·59 per acre and $13·23 per ton sugar.

General.—Other uses have been found for the portable equipment on the plantation: to soak seed cane, to irrigate potatoes and asparagus during drought and to sluice silted reservoirs in conjunction with fire hose nozzles. Piping was in good condition after two years' use and should outlive its estimated ten year life.

The results of this preliminary large-scale trial of the portable overhead system are sufficiently promising to justify a further and thorough study. In view of the varieties employed and the staggered time of planting, the yield was very satisfactory but not outstanding. Total costs, too, were not markedly different from those for surface irrigation under the best conditions. Costs would, however, be materially reduced on an installation covering 800 to 1000 acres. Operational costs would, no doubt, diminish as experience is gained. The essential objection to the portable system lies in the fact that the area per man-day is limited by the amount of piping that can be moved in an eight hour period. It may be found that the practical elimination of direct labour costs in a permanent installation may prove cheaper in the long run.

H. M. L.

A New Two-Massecuite Boiling System.[1]

By A. C. GOMEZ, A.I.C.T.A.

The attention of the sugar industry was drawn in 1938 by WEBRE[2] to new possibilities of a two-massecuite boiling system by seeding *A*-molasses. The number of crystals introduced as seed is the same as the number appearing in the final massecuite. The strike is therefore of the same purity as the *A*-molasses, which in turn is almost the same as that of the standard *C*-strike. *B*-strikes of the standard three-massecuite system are eliminated, leaving only *A*- and *C*-strikes. The commercial output is standardized as *A*-sugars.

It is claimed that the procedure of "seeding" resulted in a superior quality of sugar. As the system possesses many attractive features, a brief description of it as adopted at Skeldon Factory, British Guiana, is given in the present article, the *A*-molasses being *grained and not seeded.* This modified system still retains the main advantages of the original one.

Boiling Systems.—Preliminarily, it is pertinent to illustrate in the accompanying diagram the two most common boiling systems, compared with the new two-massecuite system.

FIG. I. OLD TWO-MASSECUITE BOILING SYSTEM. *A-B* :—

Is still occasionally encountered. The first or *A*-strike is of pre-determined purity (usually about 72·0) and this is maintained by re-circulating the *A*-molasses. The second or *B*-strike is made by boiling *A*-molasses of 44 to 46 purity on a grained footing of syrup to give a strike purity of 55. This yields the final molasses. With low syrup purities this system finds some application, but with higher purities the excessive re-circulation of *A*-molasses makes it undesirable. Another feature of this system is that the commercial product results from a relatively low purity massecuite.

FIG. II. THREE-MASSECUITE BOILING SYSTEM. *A-B-C* :—

There are three strikes, the selected purities being 78 to 80 for *A*, 68 to 70 for *B* and 55 for *C*-strikes. When syrup purities are about 80, this system has the advantage of eliminating re-circulation of molasses. Generally the quality of the sugar is better than in the old two-massecuite system as the majority is derived from higher purity massecuites. The system has the disadvantage that two types of sugar are produced (the commercial product is not standardized), and it is not as simple as the old two-massecuite system.

FIG. III. NEW TWO-MASSECUITE BOILING SYSTEM. *A-C* :—

This is the new two-massecuite boiling system described in this paper. It differs from Webre's two-massecuite system in that the *A*-molasses is *grained* and not *seeded.* The feature of this system is that all the sugars produced are derived from high purity strikes, resulting in a better commercial product. Re-circulation of molasses is kept at a minimum. It is simple compared with the three-massecuite system. Less solids are boiled per unit of sugar yielded than in either of the other systems.

A description of the new system now follows :—

Seeding v. Graining.—The main considerations which prompted the suggestion of *seeding* the pan were to reduce the tendency towards conglomeration and so produce a better curing and filtering sugar, and to control the ultimate grain size by the grain size of the seed and the volume of the seed used. However, the method presented practical difficulties such as the relatively large quantity of seed required for each strike and the very accurate boiling control necessary at the commencement of the strike.

On the other hand in *graining* the *A*-molasses there exists the difficulty of obtaining adequate crystal size for good curing, and the possibility of conglomeration occurring. Prior to attempting the graining of *A*-molasses a device[3] was constructed for projecting a magnified image of a "proof" upon a screen, where it was possible to obtain an accurate measure of grain size, etc. Adaptations were made for taking photographs. This device proved invaluable in the adoption of this boiling system involving the modification of graining the molasses.

General Procedure.—The pan station consists of one calandria pan of 1000 cub. ft. (1860 sq. ft. H.S.), two coil pans of 500 cub. ft. each (600 sq. ft. H.S. each) and one low-grade coil pan of 850 cub. ft. (960 sq. ft. H.S.).

Before the introduction of the new two-massecuite system, a three-massecuite system was in use which may be described as in-boiled *A*, straight *B* and straight *C*-strikes. The purities were 78 to 80 for the *A*, 68 to 70 for the *B* and 52 to 56 for *C*-strikes. The system now being used may be described as in-boiled *A*, purity 78, and straight *C*, purity 52 to 56, the *B*-strike having been eliminated.

The general operating procedure is as follows :—
(a) *A*-molasses of 60 to 65 apparent purity is grained.

1 Read before the Technical Sub-Committee of the Berbice section of the British Guiana Sugar Producers' Association.
2 *Proc. 6th Cong. Int. Soc. Sugar Cane Tech.*; *I.S.J.*, 1939, p. 304.
3 Similar devices are available under the trade names of Shadowgraph, Crystoscope, etc.

(b) This provides a footing on which is boiled 50 to 55 purity molasses to provide *C*-strikes. (c) *C*-sugars are mingled with syrup to provide footing for *A*-strikes which are built up on syrup and topped off with *A*-molasses to give a strike purity of 78. These yield *A*-molasses of 50 to 55 purity which may be used for either boiling *C*-strikes or topping off *A*-strikes. (d) *A*-molasses for graining is obtained by boiling pure syrup or true *A*-strikes. One granulation provides sufficient footing for four *C*-strikes.

If syrup purities are so low that 60 molasses is not obtainable, then the available *A*-molasses is blended with a little syrup to provide the required purity molasses.

FIG I. Old Two Massecuite Boiling System. A-B

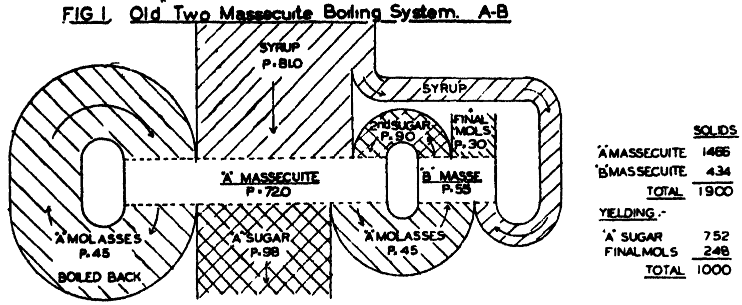


FIG II. Three Massecuite Boiling System. A-B-C

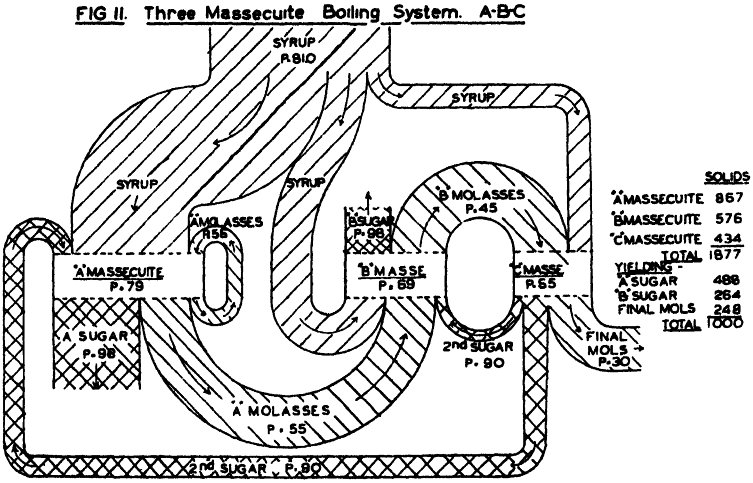
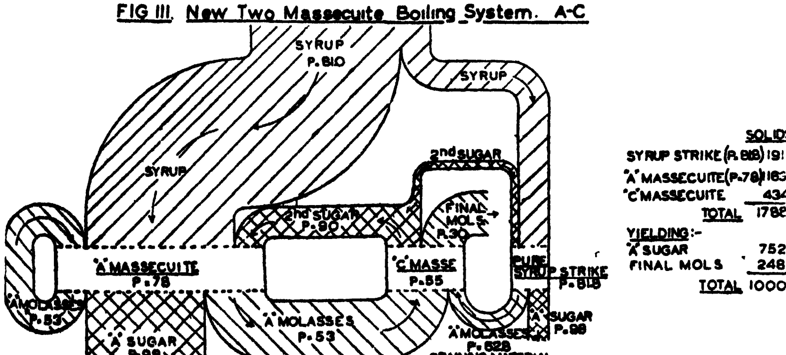


FIG III. New Two Massecuite Boiling System. A-C



Flow Diagrams: Showing flow of 1000 parts Dry Substance entering in Syrup.
(Apparent purities shown; calculations based on corresponding true purities).

Graining Procedure.—1200 galls. of 25°Bé. 60 to 65 purity *A*-molasses are drawn into one of the 500 cub. ft. pans. Vacuum 26½ in., and steam 25 lbs. gauge, are kept constant throughout the operations. The molasses is boiled down to about 650 galls. (104 cub. ft.) when 6 ozs. of icing sugar are quickly drawn into the pan. At this point the temperature of the mass in the pan is about 147°F (64°C.) and a hot thread can be drawn the full span between the index finger and the thumb (about 6 in.).

After the introduction of the shock the temperature rises rapidly to 150°F (66°C.) and remains constant until the checking charge is taken. Grain appears immediately and checking should take place within 4 to 8 mins. after the introduction of the shock. At this point the crystal shapes can just be made out on the magnifying device previously referred to.

The grain is built up on more *A*-molasses until the pan is full, thence it is cut over to the low-grade pan (850 cub. ft.) where it is further built up to about 800 cub. ft.; 600 cub. ft. of this footing are then dropped into a receiver below and 200 cub. ft. retained in the pan to be used as footing for a *C*-strike. The completed footing should have an apparent purity of about 60 for obtaining, under these conditions, optimum grain size; 50 to 55 purity molasses obtained from the 78 purity *A*-strikes are boiled on the footing to provide a *C*-strike of 52 to 56 purity.

Grain Size.—The grain obtained from graining *A*-molasses is of good uniformity and of the quadratic type. Conglomeration is not very evident and much less than in syrup granulations.

Under our conditions of operation it has been found that the grain size at the completion of the footing should be about 0·15 mm. This will give a grain size, at the completion of the *C*-strike, of about 0·3 mm. and a curing size of 0·35 to 0·40 mm.

Results.—Comparative figures for the two boiling systems: (1) the three-massecuite and (2) the new two-massecuite, are given below.

	A-B-C System.		*A-C* System.
No. of working days	36	..	90
Tons of sugar made	3909	..	8543
Purity of mixed juice	81·77	..	79·92
Tons of solids entering factory per hr. (T.S.H.)	6·86	..	6·51
Cub. ft. of 1st massecuite boiled per ton sugar	48·26	..	45·03
Time boiled per pan per hr. grinding time	36 min.	..	29·5 min.
Time boiled per pan per hr. grinding/T.S.H.	5·25 min.	..	4·53 min.
Tons of 1st sugar cured per hr. (6 baskets, 42 in. × 20 in.)	8·04	..	9·88
Tons of 1st sugar cured per basket per hr.	1·34	..	1·65
A-massecuite Brix	93·60	..	94·00
,, Purity	78·80	..	78·40
B-massecuite Brix	95·50	..	—
,, Purity	68·70	..	—
C-massecuite Brix	96·60	..	97·10
,, Purity	53·10	..	52·80
A-molasses Purity	55·30	..	53·70
B-molasses Purity	46·20	..	—
C-molasses Brix	90·99	..	90·51
,, Purity	29·22	..	30·79

These figures reveal that with the *A-C* system 3·2 cub. ft. less massecuite are re-boiled for every ton of sugar produced or, on a 12,000 ton crop, 38,400 cub. ft.; furthermore the actual boiling time is less. The importance of the above on the steam economy of the factory is obvious and it also represents an increase in the capacity of the pan station. Another marked advantage has been the large increase in the capacity of the first curing plant. This is due to the fact that only *A*-sugars are handled and that a superior curing sugar (relatively free from conglomerates) is produced.

The fact that there is a slight increase in the purity of the final molasses would indicate a falling off in the efficiency of the boiling house. However, this is due in the main to the fact that in the period in question very much lower purity juices were encountered and the second crystallizer station was pushed beyond its capacity with the result that it was not always possible to cool the low grade massecuites sufficiently, a natural adverse effect on exhaustion being the result.

Advantages of System.—The main advantages of the *A-C* boiling system may be summarized as follows:—

(1) A uniform sugar of superior quality and, therefore, of greater acceptability to refineries is produced.

(2) Less massecuite is boiled for every ton of sugar produced, resulting in an effective increase in pan capacity.

(3) The capacity of the first curing plant is increased nearly 25 per cent.; associated with this is the use of less wash-water and less labour.

(4) Steam economy is effected as the result of advantages 2 and 3.

(5) The simplicity of the system facilitates control; in comparison with the *A-B-C* system it makes boiling off at the end of any grinding period comparatively easy.

Discussion.—The adoption of the above system depends on the ability to grain a relatively small volume of molasses and this will depend to a large extent on the available equipment. In our case a little more than 100 cub. ft. of molasses is grained to provide sufficient footing for 3200 to 3400 cub. ft. of finished massecuite.

The fact that little or no conglomeration occurs is interesting, one of the benefits which it sought to gain by Webre's seeding being thus achieved. It is an accepted fact that the lower the purity of the graining material, the less the tendency towards conglomeration, and it has been suggested that this is due to a mechanical buffer effect of the impurities present which prevent the adherence of the sugar crystals.

This suggests an immediate means of improving the quality of the sugar irrespective of the boiling system used; in the case of the three-massecuite system the graining material would be *A*-molasses, but after the formation of the grain, syrup would be used for building up. Another point in connexion with the *A-C* boiling system is the possibilities of better boiling control of the low-grade massecuites, inasmuch as the purity of the mother-liquor varies little throughout the strike.

The writer wishes to thank the proprietors and management of Plantation Skeldon for permission to publish these results.

Bulk Sugar Shipment.—Trials on the shipment of sugar in bulk from Hawaii to San Francisco are being conducted by the Hawaiian Sugar Planters' Association. Permission has been requested of the territorial harbour board to install equipment including storage bins and conveyor systems. A study will be made of the probable amount of packing or caking, and the extent to which the grain may be damaged in process. An important saving in the cost of bags should result.

Notes on Milling and Milling Practice.[1]

By L. S. BIRKETT, A.I.C.T.A., A.M.Inst.B.E.

(*Continued from page* 243)

(5) *Java.*—The most recent information on milling in Java applies to the 1931 season.[2] At this date few of the mills possessed knives or shredders. Ratings are generally somewhat above normal, while the imbibition per cent. fibre is lower than is usual in most countries. A special feature of milling in Java is the flexibility of the tandems due to the practice of driving many of the mills in a train independently. The 1931 crop data is summarized in Table VI.

TABLE VI.

Equipment.	No. of Tandems.	Average. Rating.	Imb. per cent. Fibre.	A.J. lost per cent. Fibre.
9 Rolls	4	102·4	121·0	53·5
11 „	4	98·9	136·0	45·8
12 „	31	95·8	129·0	43·7
13 „	2	116·6	141·0	44·4
14 „	102	109·9	141·0	39·0
15 „	17	101·9	142·4	36·1
16 „	1	86·4	161·0	33·0
17 „	20	107·9	139·1	32·6
20 „	1	110·0	110·0	24·0

(6) *Puerto Rico.*—Average ratings in Puerto Rico are above normal, and deviations from normal are wide. One small 11-roller tandem actually operated at double its normal capacity, while no less than five other tandems gave rating indices ranging from 150 to 180. In most groups the overall mill efficiency index is above normal and this is probably due to the fact that many factories have strengthened and modernized their milling equipment. As a result, the pressures applied are generally above average.

With one exception, all tandems in the summary (Table VII), are preceded by knives, in some instances two sets being installed. The data on milling in Puerto Rico have been obtained from "The Puerto Rico Manual" (1938).

TABLE VII.

Equipment.	No. of Tandems.	Average. Rating.	Imb. per cent. Fibre.	A.J. lost per cent. Fibre.
11 Rolls	6	124·9	162·9	47·4
12 „	1	65·2	201·3	37·8
13 „	4	108·9	135·7	34·5
14 „	17	102·4	201·5	34·5
15 „	2	123·5	219·3	26·8
16 „	1	161·2	176·3	31·1
17 „	9	107·8	168·4	30·7
18 „	1	123·1	220·0	25·5
20 „	1	110·1	145·7	35·3

(7) *South Africa.*—The canes grown in this area consist chiefly of hard cane varieties, i.e., Uba and Co 281 and Co 290. The approximate percentages of the chief varieties milled in 1938-39 were as follows[3]:

	Per cent.
Uba	32·2
Co 290	35·2
Co 281	21·0
POJ 2878 and 2725	11·3
Other varieties	0·3

Of the the 20 tandems from which milling data are available,[3] 18 are preceded by knives, while five tandems also include Searby shredders. Ratings vary considerably. Imbibition is high, but in some cases complete compound imbibition is not practised. Efficiency indices are low due, apparently, to the physical characteristics of the fibre of the varieties milled.

It should be noted that both Uba and the Coimbatore seedlings appear to be more difficult to mill when grown under South African conditions than do the same varieties cultivated in the West Indies. The Coimbatore seedlings when grown in the West Indies also appear to be more resistant to crushing than are these varieties in India. Data for South African mills are given in Table VIII.

TABLE VIII.

Equipment.	No. o Tandems.	Average. Rating.	Imb. per cent. Fibre.	A.J. lost per cent. Fibre.
13 Rolls	1	105·7	236 7	50·4
14 „	7	86 5	221·1	56·0
16 „	2	79·4	199 9	52·1
17 „	6	92·4	209·0	42·8
19 „	2	115·8	247·5	44·8
20 „	1	117·3	157·0	60·1
22 „	1	98 4	201·2	41·7

(8) *Other Countries.*—Under this caption are included tandems for cane-growing areas other than those already given. The number of tandems from any one area is not sufficient to be considered representative of the area in question, and the data are included for completeness (Table IX). The chief areas represented are the Philippine Islands, the French West Indies, Santo Domingo, etc. In the Philippine Islands, ratings are generally above normal while imbibition is relatively low. The data for all tandems in that territory are summarized and presented in Table X.

[1] Read before the Technical Committee of the Berbice Sub-Committee of the British Guiana Sugar Producers' Association
[2] "Eindstatt 1931 der Molencontrol"
[3] *Proceedings of the 13th Annual Congress of the S.A. Sugar Tech. Assoc.*, 1939. "Yearbook of the S.A. Sugar Tech. Assoc., 1936-37."

TABLE IX.

Equipment.	No. of Tandems.	Average. Rating.	Imb. per cent. Fibre.	A.J. lost per cent. Fibre.
9 Rolls	1	100·4	173·3	63·2
11 „	12	113·1	155·5	35·4
12 „	3	111·4	170·2	34·0
14 „	19	99·8	163·8	31·1
15 „	2	99·3	180·2	27·2
16 „	1	110·0	115·5	30·0
17 „	3	100·3	171·1	27·1
19 „	1	128·0	50·0	49·1

TABLE X.

Equipment.	No. of Tandems.	Average Rating.	Imb. per cent. Fibre.	A.J. lost per cent. Fibre.	Overall Mill Performance Index.
9 Rolls	6	100·2	144·0	54·8	104·0
11 „	53 (4)	98'2	172·8	40·7	97·0
12 „	46 (7)	91·2	154·9	38·6	96·5
13 „	10 (10)	104·9	177·2	42·7	92·5
14 „	211 (10)	101·2	164·1	38·0	94·9
15 „	28	100·2	153·2	33·9	98·1
16 „	14 (60)	97·5	144·0	45·7	86·4
17 „	67 (20)	100·4	162·8	38·0	89·5
18 „	1	123·1	220·0	25·5	104·5
19 „	27 (74)	106·6	176·9	44·5	76·9
20 „	16 (63)	98·4	155·9	43·7	79·5
22 „	12 (42)	124·6	202·2	40·2	90·4
23 „	3	128·2	168·7	33·9	101·0
All tandems	494	100·7	164·5		92·1

CONCLUSION.

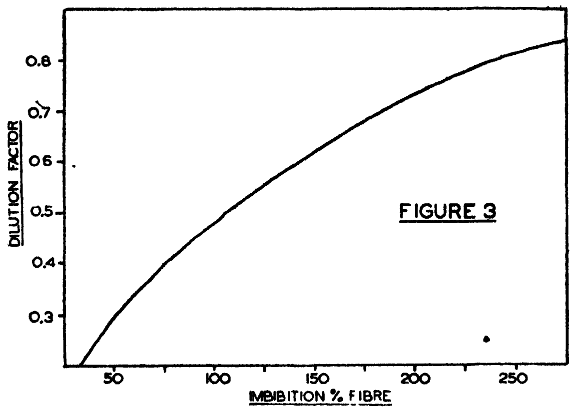
The data presented in this paper refer to 494 tandems and illustrate the general applicability of the capacity formula.[2] It will be observed that the average overall mill performance index (weighted averages) is 92 instead of approximately 100 as may be expected. This is due to the inclusion of a large number of mills where the juice sediments are returned for crushing, or at which full compound imbibition is not practised.

The relationship between the imbibition per cent. fibre and the absolute juice lost per cent. fibre (Fig. 1), was obtained only from mills practising full compound imbibition, which is standard practice. If tandems known to be practising partial imbibition and the return of sediments for crushing be excluded, the average mill performance index (all combinations) becomes 97·6.

The figures in brackets in Table X give the percentage of the tandems at which in that roller combination, partial compound imbibition or return of sediments to the mills is known to be practised. It will be seen that overall mill performance indices of appreciably less than 100 are connected with these two mill practices, as has been noted previously.

During these studies it has been noticed that in a small percentage of tandems, figures are reported that appear either too good or too poor, as far as can be judged from the information given. In many cases, the imbibition water is not weighed, but is calculated, presumably from the dilution water by use of a factor. It follows that the accuracy with which the imbibition is estimated in these cases depends on the correctness of the factor used.

The factor is a variable however, and its value



Fig, 3.

depends chiefly on the imbibition per cent. fibre, and upon whether imbibition is compound or partially so. It is possible that the nature of the cane fibre also has an influence.

The average variation in the dilution factor with the imbibition per cent. fibre is shown graphically in Fig. 3, which has been constructed from data covering a large number of countries and milling conditions. This graph is included merely for general guidance, but it is suggested that where factors in use differ considerably from those shown in it, an effort should be made to check their accuracy.

ANGLO-CEYLON & GENERAL ESTATES.—The annual Report of the Anglo-Ceylon & General Estates Co. Ltd., for the year ending March 31st, 1941, shows that the net profit was £48,150 (as against £64,960) after providing for taxation the sum of £95,000 (as against £50,000). With the balance brought in of £45,759 there was available for dividend purposes £93,909. An interim dividend of 4 per cent. less tax was paid in February and a final dividend of 4 per cent. free of tax is now paid. The two absorb £48,000 and leave £45,909 to be carried forward. The dividend of 12 per cent. gross compares with 10 per cent. declared in the previous year. In Mauritius the sugar crop was a good one, resulting in the largest amount of sugar ever harvested by the Company. Including bought canes, 358,845 tons of cane were handled on the estates, producing 41,702 tons of sugar, against 30,388 tons from 277,371 tons of cane in the previous season. The whole of the sugar was acquired by the British Government.

[2] *I.S.J.*, 1936, pp. 416-419.

Automatic Cane Carrier Regulation.

A New Patent Device.

Possibly the most annoying stop which can take place in a cane crushing plant is that caused by the stalling of the revolving cane knives. This may be the result of careless loading or speeding of the cane carrier, but if the choke is really bad it is a hard and tedious task to clear the matted mass of cane wedged firmly into the knife hood, and under the shaft.

Rather than be faced with the possibility of this trouble, nearly all modern revolving knife installations are fitted with driving units from two to three times larger than actually necessary, the extra power being required to overcome the effect of uneven loading. Even with this rather generous provision of power, knife chokes occur.

There are in use many devices for giving audible or visible warning of any overloading of the unit driving the knives. These warn the attendant in time to slow down the speed of the cane carrier until the knives are able to overcome the additional load. Such devices are not, however, foolproof, as the attendants may not respond promptly to the signals, therefore attempts have been made to make the control of the carrier speed automatically related to the speed of the knives' engine. Although many factories to-day have the auxiliaries electrically driven, there are still a very large number with steam-driven auxiliaries, and a device recently patented in Barbados makes the control of the cane carrier speed in relation to the load on the cane knife engine entirely automatic.

The principle of the device is illustrated in the accompanying sketch. Referring to this, *A* represents the cane carrier engine and *B* the knife engine. When a peak load comes on the knives the increased steam pressure in the engine steam chest is transmitted along the pipe *C* to the servo valve *D*. At a pre-determined pressure the servo valve *D* lifts and cuts off the steam to the cane carrier engine by means of the balance valve *E*. By fitting a bye-pass line *F* round the valve *E* it is possible, by regulating the stop valve *G*, to permit the carrier engine to continue working at a reduced speed without completely stopping it. The reverse process takes place when the load is reduced, and the cane carrier engine automatically resumes its normal speed.

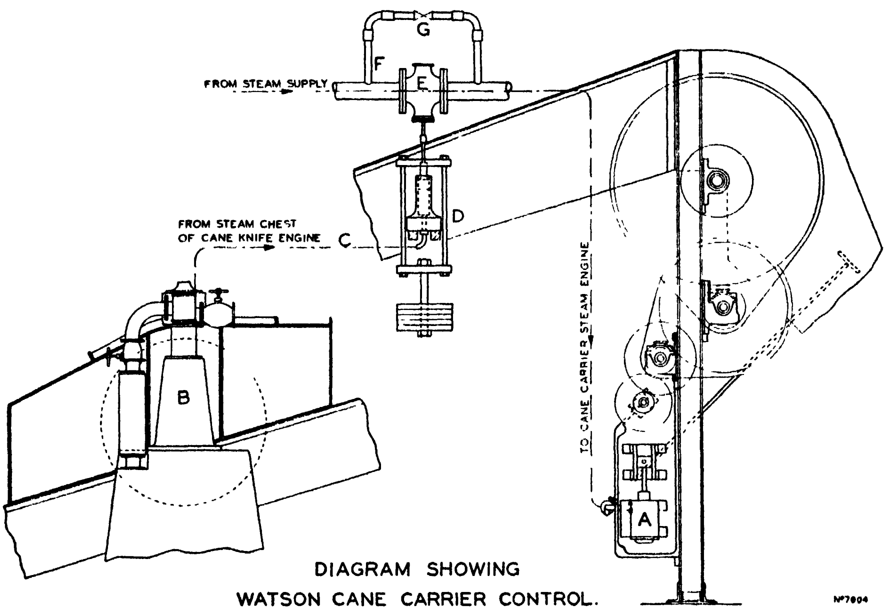


DIAGRAM SHOWING
WATSON CANE CARRIER CONTROL.

This device has been recently patented by Mr. H. C. Watson, of Searles Factory, Barbados, and the Mirrlees Watson Co., Ltd., Glasgow, have arranged for its manufacture and sale throughout the rest of the world.

Java Sugar sold to Japan.—A newspaper report from Batavia states that Japan has been a purchaser recently of Java sugar, a quantity of 100,000 tons being due for shipment during the four months from July to October.

The Assessing of Molasses Stocks.[1]

By N. SMITH.

Weight Measurement. — At the Power Alcohol Distillery, Sarina, Queensland, comparatively huge stocks of final molasses have to be accumulated in large storage tanks during the crushing season of the mills. These stocks may amount to 3,000,000 galls., or about 16,000 tons. This has to be assessed at the end of each year, and at other periods as required. Assessing of such large stocks calls for the highest degree of accuracy possible if large discrepancies in accounting are to be avoided.

One obvious method of measuring the weight of product in tanks is by means of the "Pneumercator." SPENCER states that many checks on this device have been made against actual weighing of Cuban final molasses, and a highly satisfactory agreement obtained. We have no data on the application of this apparatus to the measurement of intermediate molasses. It is felt that the instrument may be rather troublesome in such cases, due to the tendency of sugar crystals to settle out and form a solid layer on the bottom of the tanks. The Brown Juice Weigher at Pleystowe Mill, Queensland,[2] is an interesting example of the application of this same principle of the hydrostatic balance to the measurement of weights.

In the absence of such devices, the only practical method for assessing weights of materials in stock tanks is to measure the volume (in galls.), and the average density (in lbs. per gall). Hence two distinct measurements are required, and these will be considered in turn.

Volume Measurement.—Considerable care should be given to the calibrating of each tank, as the measurements are adopted for the whole life-time of the tank, unless modified. The wet dip of a tank is the depth of product in the tank; the dry dip is the depth of free space above the level of the product. The wet dip is therefore equal to the total depth of the tank minus the dry dip.

The usual procedure in measuring the dip of a tank is to measure the dry dip with a dip stick, after "flicking" away the froth from a particular patch to obtain the true level of the product. This is not always very effective, and in some cases is open to an error of about ½ in., or 1.4 per cent in the case of a 3 ft. depth of product. In the case of distillery storage tanks, the depth of froth may amount to 12 in. or more. In this case two independent estimates of the depth of froth have shown discrepancies of as much as 6 in.

Trouble due to froth with regard to dipping is obviated in the following manner: A sheet of wrapping paper is bound over the end of a piece of copper pipe 6 in. diam. by 3 ft. long. This pipe is then lowered vertically by two wires until the end sealed with paper is well below the level of the froth. The paper seal is then broken and molasses free from froth rises inside the pipe until it attains the level of the molasses in the tank; Fig. 1 shows a modified form of this dipping tube. The wet dip is then measured by lowering a steel tape, the end of which is loaded with about 2 lbs. of lead. By this means, storage tanks can be dipped with an accuracy of $\frac{1}{16}$ in., or with an average depth of 18 ft. of molasses, with an accuracy of 0·05 per cent.

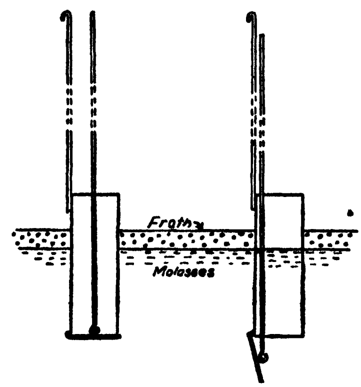


Fig. 1.—Dipping tube for molasses in tanks.

Where stocks have to be assessed each week-end, a more suitable arrangement would be a tube 4 in. diam. by 12 in. long, made of 24-gauge sheet iron, with a ½ in. diam. rod attached for raising or lowering the tube, as shown in Fig. 1 The bottom of the tube could be closed by a hinged flap of ¼ in. plate. This would be held in the closed position by means of a wire or rod until the tube has been lowered through the froth, when the flap would be allowed to open. A dry dip could then be taken in a few seconds, with complete confidence in the result. Assuming an average depth of product of 3 ft. and a dip correct to within $\frac{1}{16}$ in., the measurement of volume would be correct to within 0·14 per cent. Experience shows that six tanks can be dipped, and the volumes of material logged on the stock sheet, in about 30 min.

Molasses Density.— In order to compute the weight of material in a tank, the average density of the material, *under the conditions existing in the tank*, must be known. It is in the value given to this density that the greatest error and misunderstanding have occurred. Having measured the volume (in galls.) of a product, all that is required is the average weight (per gall.) of the product as it exists in the tank, not

[1] *Proc. Queensland Soc. Sugar Cane Tech. 12th Conf.*, pp. 75-84 (here abridged). [2] *I.S.J.*, 1940, p. 383.

at some other temperature, or in some other physical condition.

Molasses is impregnated with minute bubbles of air during the centrifugalling process. On prolonged storage of molasses (as occurs at a distillery) carbon

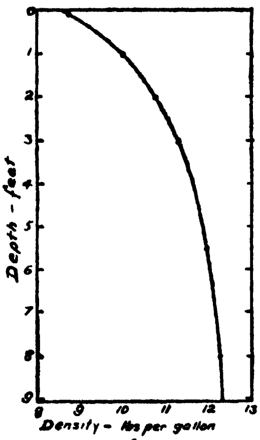


Fig 2-A, showing variation in density with depth

dioxide and possibly other gases are liberated within the molasses. Molasses in practice is a mixture of *molasses proper and gas*, and it is the volume of this *mixture* that is measured in stock-taking.

Now the average density of molasses proper is around 14 lb. per gall., whilst that of the entrapped gas is about 0·002 lb. per gall., the average density of the product lying somewhere between these two limits. Yet often a sample of the molasses is drawn and the density or Brix of the molasses proper is measured by first getting rid of the entrapped air. Obviously the correct procedure is to draw a representative sample of the product from the tank, and to weigh a known volume of this. Until recently, the practice at the Distillery was to draw a sample by means of a "diver" can from a depth equal to half the total depth of the product in each tank, and measure the density of this sample, assuming that this was the average density of the whole bulk of the product.

It however appeared that the sample may not be representative of the whole contents of the tank as regards density. It was obvious that gas bubbles tend to rise to the surface, as evidenced by the familiar phenomenon of "frothing," or, as it is sometimes termed, "fermentation." It was deduced, therefore, that the concentration of gas bubbles may not be a linear function of the depth.

Hence the standard procedure at the Distillery now is to determine the density of each of a number of samples drawn from various depths. A graph of density versus depth is drawn as the work proceeds, in order that sufficient samples will be taken to give a well defined curve. Table I and Fig. 2-A show a recent result for one of our storage tanks. From the graph, the density at each 6 in. increment of depth is read off, and by totalling and averaging these readings the average density is obtained.

TABLE I.

Depth (feet)	Density (lb. per gallon)
0·16	8·72
1·0	10·00
2·0	10·73
3·0	11·29
5·5	11·95
8·0	12·26

Results shown in Table I are at first sight almost incredible. Actually the density of the molasses proper, as measured by the 1 : 1 dilution method and corrected to the temperature of the tank, was 14·26 lb. per gall. Assuming the average density of the entrapped gas was 0·002 lb. per gall., the percentage by volume of gas in the molasses-gas mixture has been calculated by various depths from Fig. 2-A, and the results are shown graphically in Fig. 2-B.

The percentage by volume of air just below the surface is 40·3, and at the bottom of the tank is 13·5, the average for the whole tank being 20·6. Interpreted thus, the results do not appear surprising. Indeed the samples drawn from near the surface were so light and "spongy" that they would scarcely flow, and visual estimation would indicate an even higher percentage of air than shown in Fig. 2-B.

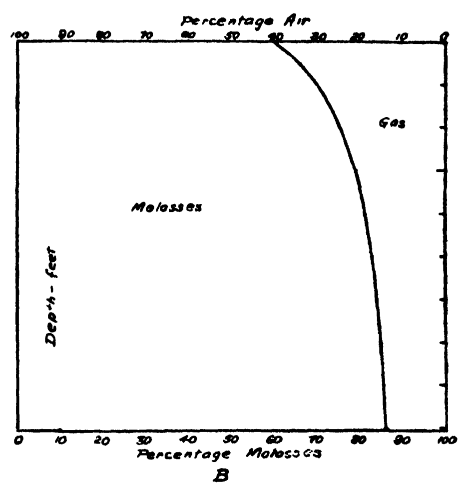


Fig. 2-B, showing calculated percentage by volume of gas in the molasses.

As stated above, the density of the molasses proper in the above case was 14·26, whereas the average density of the molasses-gas mixture as measured from Fig. 2-A is 11·33 lb. per gall. Hence if the former value were taken instead of the latter for arriving at the weight of 1,000,000 galls. of molasses, the error would be about 1300 tons, or 26 per cent. Further-

more, the density at the half-depth point is 11·79, compared with the true average of 11·33. The error in the calculated weight by using the former value would in this case be 4·1 per cent.

Samples for density determinations should not be mixed or stirred, as such mixing entraps a further amount of air, which alters the density. A test has shown that the density of a sample of molasses was 12·48 before mixing, and 12·38 after the usual amount of stirring required to ensure thorough mixing of a composite sample. The error due to mixing is in this case 0·8 per cent.

In view of these results, and the tacit appeal by HESSEY and CORVEN for greater accuracy in assessing stocks,[1] the measurement of the average density of certain sugar mill materials was investigated briefly. The results are shown in Table II, which shows that if the weights of stocks are calculated from the Brix of the products, as obtained by dilution and correction for temperature, large errors will occur in the case of molasses. The error in the above example of B-molasses is 8 per cent.

TABLE II.

Product	Temp. °C	Feet below Surface	Density—lb. per gallon: Actual	Average	Half depth	By dilution
AB-Mol.	55	0·5	13·05			
		1·5	13·15	13·13	13·15	13·83
		2·5	13·19			
B-Mol.	53	0·16	12·58			
		1·0	12·82			
		2·0	13·03	12·96	12·92	13·96
		3·3	13·31			
Syrup	56	0·16	13·00	13·05	13·05	13·16
		3·0	13·10			

It was found that the density of these sugar mill products, as determined pycnometrically, varies with the depth, and the variation was greater with lower purity products. But in the above three cases the variation in density with depth was comparatively small, and practically linear. In Table II are shown the density at the half-depth point, and the average density as calculated from graphs. In all cases there was only a very slight difference. However, there is an appreciable difference between the average density and the density at the top or bottom—2·6 per cent. in the case of the above B-molasses. Hence, in the case of molasses the average density can be assumed equal to the density of one single sample drawn at or near the half-depth point of each product.

A convenient arrangement for such sampling would be to fit stock tanks with a number of cocks. In the case of a tank 6 ft. in depth, three cocks fitted at heights of 1, 2 and 3 ft. respectively above the bottom would be adequate. The density sample would then be drawn from the cock nearest to the half-depth point of the product in the tank. The cocks should be fitted close against the walls of the tanks to minimize cooling of the sample as it is run out. For molasses, the cocks should be not less than ¾ in., otherwise sampling is too slow and undue cooling occurs in the flasks during the prolonged filling.

Apparent Density.—In the "Laboratory Manual"[2] is given a method, recommended by the International Commission for Uniform Methods of Sugar Analysis, for determining the apparent density of molasses. This method would appear far too time-absorbing for general application to week-end stock-taking. Moreover, measurement of the density at 20°C. is specified, whereas the density is required at the temperatures of the products in the tanks, usually about 55°C. At the Distillery a different procedure is followed, which is very convenient and rapid, and shows a reproducibility of results to within 0·15 per cent.

This procedure will be described : The mouth of a 300 ml. Erlenmeyer flask is ground level, preferably after grinding off the lip. The flask is dried and weighed. It is carefully filled with water level with the top and re-weighed. The last few drops of water are added with a fine pipette after placing the flask on the pan of the balance. By lightly smearing the rim of the flask with glycerin a perfectly level water surface is obtained. The temperature of the water is noted, and from Table IV of the "Laboratory Manual"[2] the volume of the flask in ml. at 20°C., V is calculated.

To determine the density of a sample of molasses, the flask is filled to overflowing by means of a funnel, or directly from a sample cock. A straight edge (such as a spatula) is immediately drawn across the mouth of the flask so that it is then filled to the brim at the requisite temperature. After washing and drying the outside of the flask it is then weighed, preferably after it has been cooled to about room temperature.

The volume of the molasses in the flask is $V[1 + \gamma (t - 20)]$ ml., where t is the temperature (°C.) of the molasses at filling, and γ is the coefficient of cubical expansion of glass, an average value for which is 0·000026 per 1°C. The density of the molasses is then given by :

$$D = \frac{W}{V[1 + \gamma (t - 20)]} \text{ grms. per ml.}$$
$$= \frac{W.\ 10{\cdot}023}{V[1 + \gamma (t - 20)]} \text{ lb. per gall.} \ldots . (1)$$

The temperature of molasses stocks all approximate to 55°C., and for this temperature equation (1) becomes :

$$D = 10{\cdot}014 \frac{W}{V} = kW \ldots\ldots\ldots\ldots\ldots (2)$$

where k is a constant for each particular flask. For purposes of week-end stock-taking in sugar mills, the simple equation (2) above may be adopted without appreciable error.

[1] *I.S.J.*, 1940, p. 383. [2] "Laboratory Manual for Queensland Sugar Mills" Second Edition, p. 97.

A convenient procedure for stock-taking would be to prepare during the off season a sufficient number of flasks for density determinations. On the weekly close-down of the factory, the volumes of all stocks are measured as indicated earlier in the text. At the same time a flask is filled from each stock tank as indicated above. The flasks are subsequently weighed and the weight of each sample is multiplied by the appropriate factor for each flask to give the required average density. The contents of the flasks may then be used for analysis. By following the above procedure two chemists could assess week-end stocks with a reasonably high degree of accuracy in the space of about one hour.

Chemical Reports and Laboratory Methods.

Sucrose Determination by Double Polarization and the Clerget Divisor. F. W. ZERBAN. Suppl. to *Archief Suikerind. Nederl.-Indië*, 1941, **2**, No. 2, pp. 1-24.

This is a Report prepared by Dr. ZERBAN in his capacity as referee on "values of Clerget divisors for the more widely used inversion methods" for the International Commission for Uniform Methods of Sugar Analysis for its intended 10th session. It succinctly summarizes the most important literature published to date in this important field of sugar literature.

Towards the end of the report is an account of some new work carried out by Dr. ZERBAN and his colleagues on the effect of the salts present in the product on the Clerget divisor. In the ½-normal weight taken were present 12, 11, 10 and 9 grms. of sucrose with 1, 2, 3 or 4 grms. of salt, viz., sodium chloride, ammonium chloride, calcium chloride, potassium sulphate and sodium aconitate. The solutions were hydrolysed by the invertase method and by the plain acid process of the A.O.A.C., at room temperature, and all readings made at 20°C., the results of the invertase hydrolysis being calculated with a divisor of 132·12 and of acid hydrolysis with one of 133·20 for 13 grms. of total solids in 100 ml. of solution. It was clear from all the results obtained that there is no general rule about the effect of these salts on the Clerget divisor, but that the effect is specific for each particular salt used. The divisor may be either higher or lower than in the absence of salts, depending on the nature of the salt, its concentration and on the method of hydrolysis used.

The summary appended to this report reads as follows : "It has been shown that none of the methods which employ hydrolysis with acid whether neutralized or not give reliable results in the analysis of cane products, mainly because of the occurrence in them of reversion products which similate the presence of sucrose. The superiority of the invertase method has been clearly established for products containing reversion products, amino-compounds and ash, provided that the Clerget divisor is based on the concentration of total solids not of sucrose, and that the solution used for inversion has the same concentration as that used for the direct reading.

"The simultaneous use along with the invertase method of Jackson and Gillis Methods II and IV will give valuable indications on the quantities of reversion products and of amino-compounds present. It is desirable that other investigators, who have not used these methods to any great extent make a further study of them. Invertase can so easily be prepared now that such investigations may be undertaken without difficulty. This work may include also a checking of the Clerget divisor for the invertase and the J. & G. methods.

"The previous findings of SAILLARD that salts do have an effect on the Clerget divisor have been confirmed. The effect is specific for each salt, varying with its nature and concentration, and also with the method of hydrolysis used (see above). Some salts increase the divisor, others lower it, and even the same salt may act either way, depending on its concentration. In artificial mixtures approaching the composition of cane syrups or molasses, the true sucrose content has nevertheless been found within the experimental limit of error of polarimetric work provided that invertase is used for hydrolysis and that the Clerget divisor is based on the concentration of total solids. This is evidently due to mutual compensation of the salt effects, and possibly to compensation by the effect of organic non-sugars.

"The concentration and temperature coefficients recently determined by JACKSON and MCDONALD[1] should be checked in order that international agreement as to their exact values may eventually be reached. Such investigations should include not only the usual range of temperatures encountered in practice, but should take into consideration also the effect of varying concentrations of sugars and non-sugars. Until this question is cleared up completely, it is recommended that all the polarimetric readings be made at the standard temperature of 20°C., and that the concentration of the solutions be read as closely as possible to 13 grms. of solids in 100 ml."

1 *I.S.J.*, 1940, p. 67.

Methods for evaluating certain Reagents (Basic Lead Acetate). C. R. VON STIEGLITZ.[1] *Proceedings of the Queensland Sugar Cane Technologists, 12th Conference*, pp. 55-57.

According to official regulations framed in Queensland,[2] basic lead acetate for use in the analysis of juice for cane payment purposes must not contain more than 3 per cent. of moisture, and not less than 70 per cent. of lead (as Pb). It must also pass a test for fineness.

Moisture is determined in the usual manner by drying a weighed amount in an oven at 105°C.; while the lead is found in the following way: A known weight of the sample, e.g., about 0·5 grm., is dissolved in 50 ml. of distilled water acidified with acetic acid, heated to boiling, and the lead precipitated as oxalate by the addition of 1 grm. of oxalic acid dissolved in water.

After cooling, the liquid is filtered, the lead oxalate precipitate washed with cold water till free of any trace of oxalate, four or five washings generally sufficing. It is then transferred to a beaker with about 50 ml. of water from a washbottle, and sufficient sulphuric acid (1 : 2 of water) added to make the liquid distinctly acid.

The oxalic acid thus liberated is titrated against N/10 potassium permanganate at a temperature of about 65°C., addition being continued until the liquid is permanently pink. Finally the filter-paper is torn up, added to the flask, and the titration continued, about 0·1 to 0·2 ml. being thus added to the previously obtained figure.

Then one calculates the total lead from the permanganate titration. If, e.g., the weight of basic lead acetate taken is 0·51 grm., and the amount of N/10 $KMnO_4$, 35·5 ml., the titre of the permanganate 1 ml. = 0·01036 grm. Pb, there is therefore present in the sample $35{\cdot}5 \times 0{\cdot}01036 \times 100/0{\cdot}51 = 72{\cdot}1$ per cent. of the total Pb.

The technique involved in this method is simple, and it gives accurate results. In order to test its reliability, a sample of lead nitrate (analytical grade) was dried at 105°C., and cooled in a desiccator. Weighed portions were placed in beakers, dissolved in water acidified with acetic acid, and the Pb determined with the following results:—

Sample taken.	Pb present.	Pb found.	Recovery per cent.
(1) 0·3452 grm. ..	0·2160 ..	0·2160 ..	100
(2) 0·3130 grm. ..	0·1958 ..	0·1961 ..	100·2

An alternative volumetric method often used is to precipitate as sulphate using standard sulphuric acid solution, then to titrate back using standard alkali. It also is easily carried out; 5 grms. of the basic lead acetate are dissolved in water; 50 ml. of N/1 H_2SO_4 added, the liquid diluted to 200 ml., the lead sulphate allowed to settle out; and 100 ml. titrated against N/1 NaOH, using phenolphthalein as indicator. But the oxalate volumetric method described above is both rapid and accurate; it has certain other points in its favour, and is the one recommended here.

Preparation of Stable Thiosulphate Solution. J. L. and E. E. KASSNER. *Ind. & Eng. Chem.* (anal. ed), **12**, p. 655.—Addition of a small amount of chloroform (about 0·4 ml. per litre) to normal solutions of sodium thiosulphate prevented deterioration over a long period, a *N*-solution prepared in December, 1936, kept in white rubber-stoppered bottles, maintaining its normality unchanged until March, 1940. Solutions of 0·05-*N* or less should be stored in brown glass, rubber-stoppered bottles.

Alcohol as Motor Fuel: Effect of Carburettor Settings. A. L. TEODORO. *Philippine Agriculturist*, 1940, **6**, pp. 465-477.—Using a 6 and an 8-cylinder engine in bench and road tests, experiments were made with alcohol and petrol (gasoline) alone and in combination. It was found that an alcohol-petrol mixture containing 10 per cent. of the former gave as efficient running as petrol alone, and developed about 5 per cent. more power with the same economical adjustment. With medium setting the engine not only developed 10 per cent. more power but also consumed 5 to 7 per cent. less fuel than on petrol alone. A 20 per cent. alcohol-petrol mixture gave less fuel consumption than petrol at economical setting, but developed about 3 per cent. less power. The difference in fuel economy varied from 3 to as high as 20 per cent., depending on the jet used. Better results were obtained in fuel economy and power with alcohol and alcohol-petrol mixtures at a high compression ratio.

Examination of Limestone. A. M. VAN LOM. *Archief Suikerind. Nederl.-Indie*, **1**, No. 12, pp. 276-279.—In this article it is emphasized that the mere chemical analysis is not a sufficient indication of the suitability of a limestone for burning to CaO for use in sugar manufacture, and that the geological nature of the stone is of great importance. Sedimentary deposits, including the chalks, are satisfactory, as are also certain marbles; but materials of the nature of calcspar should not be used, even if its chemical composition is normal, as they burn with some difficulty, and require much more coke in so doing.

Lime Salts in Clear Juices. K. L. BASU and P. C. SEN. *Proc. 9th Conv. Sugar Tech. Assoc. India*, I, pp. 151-156. — "Neither the glucose/sucrose ratio nor the turbidity, is the only criterion determining the quantity of lime salts in clear juices. Perhaps the nature of lime salts present in the juice has something to do with it. The work requires closer investigation, in view of the very important part played by Ca-salts in clear juice, influencing as they do smooth boiling, clear evaporator surfaces, and easy purging ensuring sugar of a good colour."

[1] Bureau of Sugar Experiment Stations, Brisbane.

[2] As given in the B.D.H. "Book of A.R. Standards," 2nd Edition.

Abstracts of the International Society of Sugar Cane Technologists.

Under the scheme initiated by the International Society, a collection of abstracts of papers on agricultural and technical subjects is prepared monthly. A selection from these "Sugar Abstracts" has been made by us from the material last issued, and is printed below.

Cane Agriculture.

Fertilizers applied in Java 1939 Crop. G. Booberg and J. Marchés. *Archief Suikerind. Nederl.-Indië*, 1940, No. 5, pp. 113-125.

Detailed statistics are given for each of the plantation. No great differences from preceding years are shown; mixed nitrogen-phosphate fertilizer was used on 18 per cent. of the area planted, against 17 per cent. in 1938 and 15 per cent. in 1937. The use of double super-phosphate has decreased nearly 50 per cent. (from 4 to 2½). However, sulphate of ammonia continues to be applied to the whole cane area.

Optimum Sulphate of Ammonia Tests. E. W. Clason. *Archief Suikerind. Nederl.-Indië*, 1940, **1**, No. 17, pp. 445-448.

Tests with ammonium sulphate have long been relied on in Java for determining the optimum amount of nitrogen to use in fertilizing cane. Most of these tests have been made with four (previously three) "objects" or graded amounts of the fertilizer, in steps of one quintal (220 lbs.) per hectare (2·47 acres), each object being replicated 10 or 12 times.

A large percentage of these tests have turned out to be unusable, in the sense that they gave no clear indication of the optimum amount of sulphate of ammonia to use, meaning that amount which would give the maximum commercial yield.

To improve matters it was proposed to make the tests with seven objects in steps of one quintal, and to replicate each object seven times. The experimental fields then have $7 \times 7 = 49$ plots.

Four tests according to this plan are reported. The results are very uniform in spite of the fact that the four tests were made on very different soils. In each case it was possible to identify the optimum amount of sulphate of ammonia for sugar yield. It is thought that with this type of test there should be fewer unusable experiments.

Drenching of Sugar Cane. Alexander Gordon. *Sugar News*, 1940, **21**, No. 10, pp. 395-398.

To determine the effect of drenching of harvested cane by rain on its way to the factory or in the mill yard, a series of experiments was made as follows: The first, third, fifth, etc., carloads from a given location were sent in to the mill dry; the alternate carloads from the same source were weighed dry, then drenched with a hose for 30 mins. and the increase in the weight of the cane recorded. 40 carloads of each of three varieties were tested and milled in this experiment over a period of 21 days. Conclusions are summarized as follows:—

(1) Different varieties react differently to drenching in the matter of cane weight. Drenching for 30 mins. increased the weight of Alunan by 3·66 per cent., Badila by 2·28 per cent., and POJ 2883 by 2·48 per cent. Taken as a whole, drenching may increase the weight of varieties in the La Carlota district by 3·57 per cent. This is a safe figure to be used for that area at present.

(2) The juice quality is positively affected by drenching the cane before milling. The piculs sugar per ton cane dropped by 5·39 per cent. for Alunan, 4·52 per cent. for Badila, and 3·06 per cent. for POJ 2883. Taken as a whole, the piculs sugar per ton cane may drop by 5·42 per cent.

Averages.—Taking all three varieties in the district's proportion of 79-12-9 for Alunan - Badila - POJ 2883, it will be noted that the Brix of the crusher juice for the district cane may be expected to drop by 0·8, or 4·08 per cent. Polarization may be expected to drop by 0·9, or 5·14 per cent., and purity by 0·5, or 0·56 per cent. The piculs sugar per ton cane may drop by 0·11, or 5·42 per cent.

Does increasing the Yield of Sugar per Unit of Land Surface bring More Profit? M. T. Charlouis. *Archief Suikerind. Nederl.-Indië*, 1940, **1**, No. 16, pp. 431-432.

Of late years a limit has been put on the total amount of sugar that may be produced, this limit having become necessary in order to keep production in line with consumption. The limit now applies to every plantation, so that if the planter wants to increase his unit yields, he must correspondingly decrease the area of land planted in cane. The question then arises whether anything is saved by a higher unit yield from a small area than by a lower unit yield from a larger area. On the one hand, the costs of planting and cultivating are reduced, but on the other hand there is an increased cost of the means of producing more crystal sugar per hectare.

In Java this increased cost is represented by the expense of buying extra fertilizer. Under present average conditions in Java, in order to regain the cost of one extra quintal of sulphate of ammonia, it is necessary to produce an extra 12·2 quintals of sugar per hectare. Under this condition a calculation shows that the value of the extra sugar is just balanced by the extra fertilizer cost, so practically nothing is to be gained by trying to increase unit

yields. (NOTE.—This conclusion, of course, is valid only if the plantation is not already operated at the top-notch of efficiency. The Java planters are in the habit of using sulphate of ammonia at the "optimum" rate, and naturally cannot expect to go further without clashing with the law of diminishing returns.—ED)

Irregular Production Curves in Optimum Sulphate of Ammonia Tests. M. VERTREGT. *Archief Suikerind. Nederl.-Indië*, 1940, **1**, No. 16, pp. 410-414.

When a fertilizer test on cane is made with graded amounts of ammonium sulphate, the result normally is that as the amount of ammonium sulphate added to the soil is increased, the yield of cane is increased, according to the well-known law of diminishing increments. On the other hand, the sugar content (percentage) of the cane is reduced with every increase in the amount of fertilizer. Normally, this decrease in sugar content (rendement) is represented by a curve that follows a regular downward course, but in practice on the author's plantation in Java it has been observed that this curve frequently shows irregularities, the percentage decrease being greater or less than expected.

In seeking the cause of these variations, it was suspected that the percentage of fallen or lodged cane at harvest time might have something to do with it. To test this supposition all the optimum "S.A." tests since 1932 (some 46 in all) were divided into two groups. The one group, A, included tests in which the various test plots showed large differences in the percentage of lodged cane, while the other group, B, showed little difference between the plots. Inspection of the figures of the two groups in a large measure confirms the suspicion; the connexion between percentage of lodged cane and decrease of sugar content is too evident to be ascribed to experimental error.

Summary of Cane Insect Investigations in Louisiana. J. W. INGRAM. *Sugar Bulletin*, 1940, **19**, No. 4, pp. 4-6.

This paper outlines the work at the Houma laboratory of the Federal Bureau of Entomology in 1939. The annual survey of borer depredations on ten plantations showed that 60 per cent. of the stalks were bored, which is about four times the maximum found in the four preceding years. Different varieties show different sucrose losses for the same degree of infestation, the greatest loss being in CP 28/19 and the lowest being in CO 290.

This latter variety seems to be the most resistant to borer attack. Breeding work at Canal Point has produced six seedlings that show borer resistance at Houma. These seedlings are from a cross with a New Guinea cane (NG 251) which appears to transmit borer resistance to its progeny. Crosses between noble canes and cold-resistant Turkestan canes also showed borer resistance, due in part to the smaller diameter of the Turkestan canes.

It is found that the number of live borer stages over-wintering in trash on light soils is much greater than on heavy soils. Burning the trash appears to be the best method of decreasing the number of over-wintering borers. Increasing the intensity of burning by application of 200 to 400 lbs. of sulphur per acre, or 30 to 60 galls. of Diesel oil, did not increase the effectiveness of the fire in killing the borers.

The Sao Paulo strain of the Amazon fly, which has proved of great value in reducing borer damage in the West Indies and British Guiana, was imported into Louisiana and released in 15 locations; at harvest time it was recovered in 11 of those locations. Whether this valuable parasite can survive Louisiana winters remains to be seen. Experiments in roguing out dead hearts showed that about 90 per cent. of the borers could be eliminated at a total cost of $1·61 to 1·90 per acre. Further experiments are necessary to determine the value of the method.

Small-lot experiments with cryolite have given a 90 to 95 per cent. control of the borer in small cane during three consecutive years. Experiments on a large scale with dusting machine and airplane have given promising results. An attempt has been made to reduce the number of aphids that spread the sugar cane mosaic disease by introducing lady-beetles from Puerto Rico that feed on aphids.

Injury from the sugar cane beetle (*Enetheola rugiceps*) has been reduced by an application of two or more tons of ground oyster shells per acre prior to planting. This liming appears to enable the cane to produce a larger number of shoots in the plant and first stubble crops. Varieties differ in their ability to produce shoots. The ablest varieties in this respect are Co 290, CP 29/116, and CP 28/11, which are to be preferred for planting in beetle-infested areas.

BEET AGRICULTURE.

Comparison of Manure and Artificial Fertilizers. KARSTEN IVERSEN. *British Sugar Beet Review*, 1940, **14**, No. 1, pp. 7-8, 10.

The question whether soil fertility can be maintained for years by the use of artificial fertilizers alone (without manure) is discussed in the light of long-continued experiments at five Danish experiment stations. In these experiments some plots received manure, some a quantity of artificial fertilizer equivalent to the plant food contained in the manure, and some received nothing. All plots were carried through the years on the same rotation. The yields of all the crops have been reduced, for purposes of comparison, to the common basis of feed units.

From results obtained at these two stations, one on a clay and the other on a sandy soil it was noted that the artificial fertilizers consistently yielded more than the manures and that the untreated plots yielded the least. Similar results were obtained on loam soils,

Analysis of the soils of the three categories of plots laid down on a clay soil (Askov) showed that after many years the farm-yard manure plots contained more nitrogen, and, in addition, more humus, than the soil which had received only artificials. More phosphorous acid, however, was present in the soil which had received dressings of artificials. The untreated soil, as might be expected, showed the lowest quantity of each of the three nutrients.

The difference in humus content between the soil to which farm-yard manure had been applied and that which had received artificials amounted to about 2640 lbs. per acre. The quantity of organic matter remaining in the soil which had received no treatment for 30 years was no greater than could be theoretically replaced by six loads of low peat moss per acre, or one load every fifth year.

The experiments at Askov also showed that more bacteria were present in the artificial plots than in those which received farm-yard manure; there were fewest of all in the unmanured plots. It would appear, therefore, that measures which stimulated crop yield also stimulated bacterial life in the soil.

BEET TECHNOLOGY.

Phosphate as a Deliming Material. P. ANDRIES. *Zeitsch. Wirtsch. Zuckerind.*, 1940, **90**, pp. 228-233.

Addition of superphosphate was begun at a rate corresponding to 0·013 per cent. of P_2O_5 on beets, the operation being conducted as follows : 5 kilograms of the phosphate were suspended in 60 litres of thin-juice, and at five-minute intervals 5 litres of this suspension were dipped into the thin-juice trough of the second filter-press battery. The thin-juice thus treated was filtered, boiled-out, and concentrated in a pressure triple effect, after which the thick-juice was filtered.

The general result was a reduction of somewhat more than 20 per cent. in the lime content between thin-juice and thick-juice. Where it had previously been necessary to shut down every three weeks to remove scale, there is now continuous operation to the end of the campaign. There is no foaming in the evaporators. Mud cakes easily come off the filter-cloths behind the juice boiler and from the thick-juice filter, probably due to the presence of gypsum which acts as a filter-aid. In some cases it is necessary to use as much as 0·03 per cent. of P_2O_5 on beets. Ordinarily 0·02 per cent. will be required, but in any case 0·01 per cent. is too little. Trisodium phosphate was not found to offer any advantage over superphosphate.

Influence of Alkali Phosphates on Deliming of Thin-Juices and on Incrustation in the Evaporators. O. SPENGLER, S. BÖTTGER and W. DORFELDT. *Zeitsch. Wirtsch. Zuckerind.*, 1940, **90**, pp. 207-227.

Attempts to use trisodium phosphate for the purpose of removing incrusting salts from beet juices have been made with generally favourable results, but some points remain to be cleared up.

In a laboratory phase of the investigation thin-juices of medium and high lime contents were delimed with equivalent amounts of alkali phosphates and soda. In all cases the phosphates proved superior. Trisodium phosphate was the best; disodium phosphate was almost as good, and the monophosphate was only slightly inferior.

Trisodium phosphate and soda both increase the ash content, but soda most. The monophosphate decreases the alkalinity and the *pH* ; the diphosphate has little or no effect, while the triphosphate noticeably increases alkalinity and *pH*. These relations suggest the following rule : when it is desired to minimize the effect of a too great natural alkalinity, use the monophosphate for deliming the thin-juice; where precaution is to be taken against two great a decrease of alkalinity during evaporation, use triphosphate, and when neither change is expected or desired, use diphosphate.

In a practical test, 900 litres of thin-juice (hardness: 50 German degrees) were treated with equivalent amounts of trisodium phosphate or soda at 95°C., and after ½ to 1 hour stirring were evaporated (without previous filtration) in a quadruple effect evaporator. A blank test (without deliming agent) was made for comparison. In comparison with the blank, the triphosphate decreased incrustation 78 per cent., while soda increased it 1·60 per cent. Even with filtration, the incrustation was worse with soda.

New Photo-Electric Saccharimeter. O. SPENGLER and H. HIRSCHMÜLLER. *Zeitsch. Wirtsch. Zuckerind.*, 1940, **90**, pp. 426-437.

The firm of B. Lange has submitted a new instrument utilizing the photo-electric cell in reading to the Berlin Sugar institute for test, the general scheme of which is : A source of sodium light sends a beam through the two halves of a polarizer whose polarization planes are perpendicular to each other; that is, they form a half-shadow angle of 90°; the light then passes through the polarization tube and analyser and is directed by a lens upon two adjacent differential photo-electric cells. In this manner the lens throws the light from one-half of the polarizer on one cell while the light from the other half is thrown on the other cell. These two cells are electrically connected through a compensating rheostat with a galvanometer. The analyser is removable.

A measurement is carried out as follows : The polarization tube is filled with the solution, the analyser is removed, and the needle of the galvanometer is adjusted to zero. The analyser is replaced and the galvanometer needle again turned to zero, the result of the measurement being then read from the dial. The sensitivity of the apparatus was found to be 0·017° (= 0·1 per cent. sugar in a 10 cm. tube) which is sufficient for the purposes of the sugar industry. This first model was found to have some technical defects which will be removed in a new model under construction. It simply aims at eliminating the observer's personal equation, which enters into matching the illumination of the two halves of the field. He merely notes the position of the galvanometer needle.

New Books and Bulletins.

Technology for Sugar Refinery Workers. By OLIVER LYLE. (Chapman & Hall, London). 1941. Price : 15s. net.

While there are many books dealing with the manufacture of raw sugar those on refining are few, and in English there is only one, that of BARDORF and BALL, which treats of the subject in detail. The appearance then of a new work, written by Mr. OLIVER LYLE, of the third generation of a famous refining house, should receive a special welcome.

The work divides itself into two parts. The first portion is a general introduction to technology as applied to sugar manufacture, and includes accounts of *pH*, of the principles of sugar analysis, and of the production of steam and of electric power. This part contains no striking or novel features, and is evidently intended to afford employees a convenient means of reference, explanatory of the general principles governing the processes, the operation of which they control. It can be said that this object is achieved.

The second part of the book is entirely devoted to sugar refining and its problems, both technical and economic. It is easy to see that the subject matter here is based on the accumulated experience obtained over three generations in the refineries of Henry Tate & Co. at Silvertown, of Abram Lyle & Sons at Plaistow Wharf, and of Fairrie & Co. at Liverpool. On the technical side are discussed many intimate details of refining practice, which up to the present have been regarded as mysteries, on no account to be divulged to any but the firm's initiates. Of particular interest are the pages on the carbonatation process as applied to refining, which was, we believe, kept a jealously guarded trade secret for many years, the operation of the char filters elucidated by carefully constructed diagrams, and the statement that between 1937 and 1940 the consumption of coal at Plaistow Wharf was reduced from 22·4 per cent. to 13·4 per cent. on sugar melted, indicating a saving of 100 tons of coal per day.

Of equal importance is the resumé on page 326 of the "Reasons for a Refining Industry." These are well taken, and Mr. LYLE lays stress on the economic rather than on the technical side, and formulates the principles which are as true to-day as when in the fifteenth century Venetian merchants established a refining industry in that city, drawing their raw material from the plantations in Cyprus, Rhodes, Syria, Crete and Sicily.

There are many other points of interest to which in the limits of a review a bare reference only can be made. Those on control confirm the remark made by AL NUWAIRI 600 years ago of Egyptian practice : "The control comprises many things that one cannot put in a book and presents also things that one can hardly say in speech."

While the remarks made above only serve to call attention to a treatise which must be read to be properly appreciated, there are some errors of which notice must be taken. BEAUMÉ should be BAUMÉ, and DEER should be DEERR. More serious is the unhappy lapse which attributes German birth to NICOL, the Edinburgh lapidary and lecturer on natural philosophy; and finally on page 79 there is some confusion as to the functions of the analyser and quartz wedge compensator as used in the polariscope.

The printing and get-up of the book afford no opportunity for adverse comment, the illustrations, all of which have been prepared by the author, being especially to be commended. The index is more than usually full, and has patently been compiled with care.

N. D.

Glossary of Terms used in Queensland Cane Sugar Factories. Compiled by the Technology Division (Bureau of Sugar Experiment Stations, Brisbane, Queensland). Technical Communication 1940, No. 9.

With the object of encouraging standardization of terms used in the manufacturing side of the sugar industry in Queensland, a list of equipment, materials and products has been compiled, and is here presented. Brief descriptions have been given rather than bare definitions. Terms concerned with chemical control follow generally the standard definitions formulated by the International Society of Sugar Cane Technologists in 1929. Probably the most noticable departure from the usual Queensland terminology is the distinction between the terms mill and factory, which are no longer synonymous.

South African Sugar Year Book, 1940-41. Compiled by the *South African Sugar Journal*, Durban, Natal. 1941. Price : 5s. post free.

This is the annual reference book and guide to the sugar industry of South Africa. One of the opening articles consists of a detailed account of the South African sugar season of 1940-41. Full details are given in the pages of the various associations connected with that industry. An important section is a list of the Natal and Zululand sugar milling enterprises, giving brief accounts of the history and progress of each unit. All the necessary statistics of this important South African industry are to be found in this work, which will serve a useful purpose for those who desire to get into touch with these sugar interests.

Brevities.

THE LATE HENRY HURTER.—We are sorry to announce the death recently of Henry Hurter, chief engineer to the Fulton Iron Works Co., of St. Louis, at the age of 65. He had joined this organization as an apprentice in 1891, since which date he had remained with it. Well-known in sugar circles in the West Indies, he had contributed to numerous improvements in the design of cane milling equipment.

AUSTRALIAN EXPORT UNCERTAINTIES.—At a Sugar Technologists' Conference held at Cairns, Queensland, in April, the Queensland Minister of Agriculture warned his hearers that the recent acquisition of the 1941 Australian sugar crop by Proclamation must not be taken to imply that a market had been found for whatever might be produced. For the present there must be restraint in planting, otherwise he could only visualize increased and possibly insuperable difficulties in 1942.

LOUISIANA D.C. SUGARS.—Eastern seaboard refiners in the U.S. have raised charges against Louisiana direct consumption sugars of containing impurities in nature and amount as to render such sugars unsuitable for the manufacture of candy and cakes. After a tour of inspection of Louisiana sugar factories by Walter Sale, Government expert, this allegation has been refuted, and Louisiana direct consumption sugars have been certified by the Pure Food and Drug Administration as acceptable sweetening ingredients for chocolate and other products.

POWER ALCOHOL PROBLEMS IN AUSTRALIA.—The Queensland Minister of Agriculture speaking recently at a Technologists' Conference at Cairns said that in respect to the problem of making power alcohol from sugar and its by-products, no expediency that might finally undermine the security of the economic structure should be lightly accepted. The price of the sugar under the Peak scheme was the determining factor in the industry. To undermine that structure as a matter of expediency was a question that required close scrutiny. He agreed with the idea of producing power alcohol but saw very definite economic factors that would operate if some of the projects that were contemplated were put into effect and it might be difficult thereafter to regain the economic structure of the sugar industry.

BRITISH FOOD MINISTRY PURCHASES.—The probability, foreshadowed some months ago, that the Sugar Control in the United Kingdom would have to look nearer afield for some of its purchases rather than buy solely Empire sugar, owing to the long voyages involved in bringing the latter to the United Kingdom, seems confirmed by market reports published in Cuba and New York as to purchases of late months of Cuban sugar. Thus on July 10th Luis Mendoza & Co. stated that from May to that date Cuba had sold 260,000 tons to U.K. and Canada. Presumably the larger part of this went to the U.K. New York reported 100,000 tons of this as having been purchased at the beginning of July at a price of 1·05 to 1·08 cents, f.o.b. Cuba. On August 7th New York market reported a further purchase by the U.K., believed to be 100,000 tons at 1·75 cents, for September-October delivery. On August 15th a further 25,000 tons Cuban sugar at 1·65 cents was reported as purchased for same period of delivery. World prices (No. 4 contract), which at the beginning of June were as low as 0·80 cent, rose steadily during June and July and reached a peak in the first week of August of 1·83 cents. Subsequently there was a temporary decline of about 20 points, but later a new peak of 1·88 was reached by August 21st.

U.S.A. CONFECTIONERY.—The United States confectionery industry uses approximately 400,000 tons of sugar annually. Sales of confectionery during 1940 were valued at about $336,000,000, giving a record of 16·9 lbs. per head consumption. The favourite form of confectionery sold is stated to be chocolate-covered bars.

P. C. & W. CENTRIFUGALS.—Some of the advantages of using Pott, Cassels & Williamson single speed, electrically-driven centrifugals fitted with variable speed fluid couplings are claimed to be: mechanical unloaders with single speed motors, no shock to the motors, no friction blocks, enormous reduction in switch repairs, no inching, and smooth acceleration.

BEET GROWING IN LOUISIANA.—Sugar beet has been grown on about 20 acres of Westover plantation, La., and on being harvested in March/April of this year was found to give juice having a sucrose content of 20·9, a purity of 89·9 and a Brix of 23·3. This was on land which had produced two heavy crops of cane, and had not been fertilized: they were cultivated only once, and had not been thinned or blocked.

BRITISH SUGAR CORPORATION.—At the beginning of August the British Sugar Corporation (which controls the beet sugar factories in England) declared an interim dividend on the Ordinary shares on account of the year ended 31st March, 1941, of 4½ per cent. less tax. At the same time the Directors stated that, owing to circumstances outside their control, they were unable to present a Balance Sheet and Profit and Loss Account for that year at this stage, and that the annual meeting would have to be postponed until the accounts had been passed by the Government Departments concerned. It is not the Board's intention to recommend a further dividend in respect to 1940-41.

COLONIAL SUGAR REFINING CO.—The annual report of this Australian sugar company, for the year ended March, 1941, shows that after providing for depreciation and other charges the net profit for the year from the work of the factories and from other investments amounted to £1,054,331. Adding the sum of £472,388 brought in on April 1st, 1940, and deducting £497,250, the amount of the interim dividends paid in November, 1940, a net sum was left available of £1,029,469, out of which a final dividend of 17s. per £20 share is being paid, absorbing £497,250, and making 8½ per cent. for the year. A sum of £50,000 is placed to reserve account which now will stand at £1,200,000, and the balance of £482,219 is carried forward.

CLARIFIER PATENT CLAIMS.—A suit was filed by the Dorr Co. (and associates) for alleged infringement of patents by the use of sugar clarification apparatus manufactured by the Graver Tank & Mfg. Co. The case was tried in the District Court, Puerto Rico, before Judge Robt. A. Cooper, who dismissed the complaint, and held that the patent claims at issue were invalid because of anticipation and lack of invention. The complainants appealed, the decision of the higher court by Judge Calvert Magruder re-affirming the lower court's finding in the following words: "The District Court found that 'the accused device infringes both the Coe and the McHugh patents, assuming the validity of the said patents.' This finding is challenged by the defendant, but it is unnecessary for us to examine into its correctness, because we feel obliged to affirm the court below in its conclusion that the Coe and McHugh claims are invalid."

Sugar-House Practice.

Bagasse Furnace Operation and Design. K. S. ARNOLD. *Proc. 9th Conv. Sugar Tech. Assoc. India*, pp. 97-108.

Operation.—Figures for the CO_2 content and temperature of flue gases must be accompanied by the associated figures for the CO content and the temperature of the gases prior to coming into contact with the boiler heating surface. It is desirable also to have information on the relative quantity of air being supplied to the furnace, and the corresponding draught, and for these the O_2 content of the flue gases and the draughts in the furnace itself and at the back of the boiler are necessary.

To take the temperature immediately in front of the boiler heating surface would introduce an error, since at this point the gases have been cooled down to a certain degree by radiation. It will be sufficient to take the temperature at a point 4 to 6 ft. from the heating surface, as near as possible in the middle of the flow of gases. To measure this temperature (1500 to 2300°F.) the thermo-couple type of pyrometer may be used, but it is subject to deterioration at the high degree to which it is subjected, and to certain other disadvantages. An instrument of the optical type, as the disappearing filament pattern, is more suitable. It works on the principle of comparing the intensity of light emitted from an incandescent surface with that from a filament illuminated by an electric current.

Appearance of the gases is important. Two furnaces may show almost identical results as regards flue gas composition and temperatures, but may be operating very differently. Combustion may be complete in both cases (no CO present) but there may be a considerable loss in one case owing to the entrainment of particles of bagasse, which pass through the furnace and deposit in the flue or discharge from the chimney. When all the fuel is being consumed, the gases will be invisible, without sparks or flaming particles.

A mercury-in-steel thermometer can be used for taking the temperature of the flue gases (up to 700°F.), and should pass well into the path of the gases, for which purposes a stem of about 4 ft. should be specified. Its position should be in front of the damper and on the vertical centre line of the rear wall of the boiler, from which position samples for analysis should also be withdrawn. In the case of the usual boiler arrangement with a chimney of normal height and without auxiliaries and fans, the reduction of the temperature of the flue gases will depend on the steam temperature corresponding to the pressure in the boiler. It may be taken as about 100°F. higher than the steam temperature, which for a boiler working at 160 lbs. pressure will be 470°F.

In interpreting the results of flue gas analysis, if CO is absent then combustion was complete, the proportion of O_2 indicating the amount of air supplied in excess of the theoretical amount for combustion, but the excess of air may have been excessive. In good furnaces working to capacity the minimum excess air for complete combustion is around 40 per cent. more than the theoretical, giving a flue gas of approximately 13·5 per cent. of CO_2 and 6 per cent. of O_2. Figures over 13·5 are usually associated with appreciable amounts of CO in the flue gases indicating incomplete combustion. If CO is present in say over 0·4 per cent., various conditions may be responsible :—

(1) Air supplied may have been insufficient (CO_2 high and O_2 low); (2) gaseous products from grate improperly mixed with the air supplied (CO_2 low and O_2 high); (3) ignited products burnt out before extinguished against the heating surface of the boiler (again CO_2 low and O_2 high); and (4) combustion incomplete, the temperature being insufficiently high (yet again CO_2 low and O_2 high).

Clewiston : Largest Sugar-House in the U.S. H. T. VAUGHN. *Facts about Sugar*, 1941, **36**, No. 2, pp. 24-31.

Situated in the heart of the Florida Everglades, and the property of the U.S. Sugar Corporation, its grinding rate is more than 6000 tons of cane per day. It has a demonstrated capacity to grind 1,150,000 tons of cane in a normal season, resulting in an extraction of over 125,000 tons of 96° raw sugar A side-dump hydraulic tilting table empties the railroad cars on to a conveyor, moving at right angles to the main carrier. Mounted in the first conveyor is a motor-driven "kicker," and a set of motor-driven Scharnberg heavy-duty cane knives which act as levellers, their cutting edges being set about 3 ft. from the bottom of the carrier. Another similar kicker is mounted in the main carrier ; while just above the headshaft of the main carrier is another set of Scharnberg knives, the blades of which are just set clear of the slats of the carrier. This latter knife set, therefore, does a thorough job of shredding.

The milling plant consists of a Fulton-type crusher, 40 in. × 78 in., driven independently by a 22 in. × 42 in. Hamilton-Corliss engine. There are seven 35 in. × 78 in. mills in the grinding tandem : the first is a new Scharnberg-Farrel type, electrically driven by a 300 h.p. motor ; the second, third and fourth are Hamiltons, driven by a 36 in. × 60 in. Hamilton-Corliss engine ; while the last three are Fulton-type, driven by a 38 in. × 60 in. Fulton engine. Differential angle grooving is used in all rolls. The crusher rolls are provided with 3 in. pitch circumferential grooving and cross grooving, so arranged that the mesh is similar to a pair of herring-bone gears. The first and second mills have 2 in. pitch, the third and fourth 1½ in., the fifth and sixth 1 in., and the seventh 1 in. on the cane roll and ½ in. on the top and bagasse

rolls. All turnplates are provided on the backside with tapered slots for free juice discharge; very little bagasse can find its way into the juice pans, as the rear of the turnplate meshes closely into the grooving of the bagasse roll. Clarified secondary juice is applied on the first, second, third and fourth mills, and hot water on the fifth, sixth and seventh mills.

Compound clarification is practised. Primary juice, consisting of juice from the crusher, first, second, third and fourth mills, and the clarified secondary juice, is limed in the mill juice pit to about 7·5 *pH*, the milk-of-lime being added continuously by means of a weir arrangement, graduated in terms of cane varieties. The liming station for the secondary juice is located adjacent to the primary clarifiers, and this operation is carried out to 7·3 *pH*. There are two 20 ft. 5-tray converted Seip-type clarifiers, and one 18 ft. 5-tray Dorr for the primary clarification; one 22 ft. 4-tray, and two 18 ft. 3-tray Dorrs for the secondary. Mud from the secondary is diluted with water, *bagacillo* being added as filter-aid, and the mud filtered through two 8 ft. × 16 ft. Oliver-Campbell vacuum filters. Juice from the vacuum filter station is added to the clarified second juice.

On leaving the primary clarifiers, the juice flows to a set of 20,000 lb. capacity Howe juice scales mounted over an evaporator supply tank. Evaporation is performed in various combinations: the installations consist of two standard quadruple effects with a h.s. of 41,000 sq. ft., a Webre triple of 21,500 sq. ft., which can be used under pressure or condensing, and two single-body pre-evaporators with 5700 and 9000 sq. ft. h.s., the larger one of which can be used singly or in combination with the Webre as the first body of a quadruple effect. Vapours from both pre-evaporators and triple effect are used for juice heating and boiling water.

The pan installations consist of six calandria and one coil pans, one 10 ft., one 7 ft., and five 13 ft. in diam. In boiling, the 3-massecuite system is used, the *C*-massecuite being boiled in the calandria pans equipped with the Scharnberg sugar "homogenizers" with movable downtakes, the time required being approximately 4½ fours. Thirteen open-type crystallizers are used for the *C*-massecuites, the period of storage being about 20 hours. The *A* and *B*-massecuites are dried with a battery of ten 40 in. × 24 in. direct-driven centrifugals, while the *C*-massecuites are purged with a battery of fourteen 40 in. × 24 in. belt-driven machines. As a means of decreasing the cycle in purging *C*-sugar, the massecuites are re-heated to 130°F. in a mixer equipped with Rolston coils.

The bagging hopper is equipped with a Richardson automatic sugar scale, each bag being re-weighed on Fairbanks platform scales. Final molasses is weighed through an 18,000 lbs. capacity Howe scale, and the storage capacity for this by-product aggregates 5 million galls. The boiler installation consists of one bank of three 1000 h.p. Edgemoor boilers and one bank of four 500 h.p. Babcock & Wilcox's, these latter having recently-built Hofft furnaces. All the raw sugar from Clewiston is shipped to the Savannah Sugar Refining Corporation, Port Wentworth, Georgia, for refining there.

The Diatom in Filtration. ROBT. W. KENT.[1] *Sugar*, 1941, **36**, No. 5, pp. 26-30.

Three of the main factors in the filtration of sugar liquors are viscosity, temperature and amount and character of suspended impurities. Illustrating the relationship between the density of a pure sugar solution and the viscosity at 90°C., a curve is given in the original article, according to which for every degree change in the Brix in the neighbourhood of 60°Brix there is a 7 per cent. change in the viscosity (millipoises). If further the temperature is dropped from 95 to 90°C., a 15 per cent. increase in viscosity will result, and consequently a 15 per cent. decrease in the rate of flow.

The primary function of the diatomaceous filter-aid is to dilate the slimes and other insoluble impurities in the liquor, in order that the cake which forms in the frames of the presses may be porous and allow the free flow of juice through it. There is an optimum amount which should be used; to use less reduces the flow, cuts down the press life and affects the clarity; while to use more is to reduce the flow, and cut down the press life without any proportional gain in clarity.

As is well known, the most efficient filtration is carried out under a gradually increasing pressure cycle during which the pressure is slowly raised from hour to hour to maintain a constant volume of flow. Filter-presses can give good results with modern filter-aids. Of late the type having the outlet at the top instead of at the bottom has received attention, it being claimed that the pre-coating may thus be carried out more easily and more efficiently, that trapped air in the frames is eliminated, and that there is less chance of contamination of clarified juice in the trough. Addition of filter-aid may be made with a dry or a slurry-feeding device, the former being considered the better for uniform dosing and for varying the amount when necessary.

Using the proper grade of filter-aid is important, the object in view being to get the maximum capacity from the presses. To-day different grades of diatomaceous material with varying flow rates are being produced, it now being possible to meet any condition in sugar filtration. By press capacity is meant the number of square feet of filtering area per ton of beets sliced. In different beet sugar houses, for example, it is found to vary from about ½ to 2 sq. ft. per ton of sliced roots. In a non-Steffen house, it should not be less than about 1·3.

It is not easy to measure the efficiency of filtration, but there are certain means which may be applied.

[1] Chemical Engineer, The Dicalite Co.

One may calculate, for example, the hourly throughput thus : Gallons of standard liquor filtered ÷ (No. of hours) × (Sq. ft. filtering area). If this figure be multiplied by the average press life, the result is the cycle throughput, i.e., the number of gallons put through 1 sq. ft. of filtering area per cycle.

This cycle throughput is a significant figure, definitely more important than the press life, which obviously depends a great deal on the press capacity and on how much liquor is put through the presses. One can calculate the maximum cycle throughput that could be obtained theoretically for any given percentage of filter-aid and for various sized frames. Thus, assume a filter-aid density of 16 lbs. per sq. ft., and let P = the percentage of filter-aid by weight in the standard liquor, then the maximum theoretical cycle throughout for various sized frames of presses is :—

1 in. frame $\frac{66 \cdot 67}{P \times F}$ gall./sq. ft./cycle

$1\frac{1}{4}$ in. frame $\frac{88 \cdot 33}{P \times F}$ gall./sq. ft./cycle

$1\frac{1}{2}$ in. frame $\frac{100 \cdot 0}{P \times F}$ gall./sq. ft./cycle

Evaporator Cleaning Practices in Louisiana. ARTHUR F. KELLER.[1] *The Sugar Journal* (Louisiana), **3**, pp. 27-28, 30.

A questionnaire was sent out to some 60 of the sugar factories in the State of Louisiana during the 1939 season, asking for information on the methods employed in cleaning the heating surfaces of evaporators. A good response was obtained. The first question concerned the chemicals employed, these being given as sodium hydroxide (36 factories), soda ash (24), hydrochloric or muriatic acid (40), "co-acid" (7), and "Oakite (1). Generally the sodium hydroxide (caustic soda) and soda ash (sodium carbonate) are used together, a mixture of 60 to 75 per cent. of the first and 40 to 25 per cent. of the second being reported as being more effective than NaOH used alone.

One of the factories reported that its heaters were kept clean by pumping cold unlimed juice through their spare units continuously; so that by changing heaters at 12 or 24 hourly intervals they were able to keep the surfaces in excellent condition at all times. It is, of course, the acids present in the raw juice together with the erosive effect of the suspended solids that is probably responsible for this cleaning effect.

Replies were received to the question as to the concentration of the sodium hydroxide and soda ash used for evaporator cleaning, and from these it appears that the average concentration varies from 2·5 to 6 per cent. In the case of the muriatic acid, the figure is 1 to 3 per cent. Some factories are using higher concentrations for cleaning, an "inhibitor" being added to prevent the HCl from attacking the metal of the heating surface while still dissolving the calcium carbonate and other scale.[2] Seven of the factories use such preparations.

A phase of the scale-cleaning problem which has not received proper consideration is the disposal of the chemicals after cleaning has been accomplished. Not all the Louisiana factories have proper alkali and acid storage tanks, and are obliged to ditch their liquors after each cleaning. Provision of such tanks would certainly be justified from the points of view of economy and convenience.

There is a wide variation in the lengths of the cleaning periods reported from the various factories in Louisiana. In 25 out of 40 factories, the time taken for the NaOH and Na_2CO_3 was 3 to 6 hours, five taking less than 3 hours and seven more than 6 ; while for boiling with HCl 27 of the factories took from $1\frac{1}{2}$ to $2\frac{1}{2}$ hours, eleven taking less than $1\frac{1}{2}$ hours and four taking more than $2\frac{1}{2}$ hours.

Lastly, the amount of the chemicals used is discussed and most of the factories taking part in the questionnaire recorded this figure. In the case of the NaOH and Na_2CO_3, 25 factories state their consumption to be from 0·11 to 0·20 lb. per ton of cane ; two using less and three more than here specified. In that of the muriatic acid (18°Bé. HCl), 33 factories use between 0·02 and 0·30 lb. per ton of cane with one only using less and three using more.

Silent heaters, circulators and similar devices are being installed in increasing numbers, these heating up the chemical solution better, and speeding up considerably the cleaning operation. It may also be pointed out that the lowering of the *pH* of the clarified juice has apparently reduced scaling troubles in a number of factories, particularly in the Teche section, and during the past season most factories were carrying clarified juices at a *pH* of 6·0 to 6·4, and apparently without any loss of sucrose by inversion.

Sulphitation Methods in India. S. V. RAMANAYYA and S. S. SASTRY. *Indian Sugar*, 1940, **3**, No. 10, pp. 19-22.—Sugar prepared by three different sulphitation methods (viz., sulphuring after hot liming, sulphuring after cold liming, and pre-sulphitation, i.e., sulphuring before liming) were exposed to humid conditions and periodically analysed for moisture pol. and reducing sugars. Conclusions were as follows : It seems clear that the pre-sulphitation method is by far the most suitable one for the manufacture of superior white sugar having a good resistance to deterioration. Only a few factories in India are employing it at the present time. It may be necessary for these to revise their ideas on hot pre-liming, and to adopt this pre-sulphitation process as the most suitable chemical process. Even in Java it is being favoured.

[1] Louisiana State University.

[2] *I.S.J.*, 1940, p. 368.

Review of Recent Patents.

Copies of specifications of patents with their drawings can be obtained on application to the following—*United Kingdom*: Paten Office, Sales Branch, 25, Southampton Buildings, Chancery Lane, London, W.C.2 (price 1s each). Abstracts of United Kingdom patents marked in our Review with a star (*) are reproduced with the permission of the Controller of H.M. Stationery Office, London, from the Group Abridgements issued by this Department. Sometimes only the drawings are so reproduced. *United States*: Commissioner of Patents, Washington, D.C. (price 10 cents each).

UNITED KINGDOM.

Working and Extraction of Materials in Diffusion Batteries. British Sugar Corporation, Ltd., and Robert Jorisch, of The Adelphi, London, W.C.2. 533,640. August 12th, 1939.

In accordance with the present invention, the normal mode of operating a diffusion battery is modified by dividing the battery into two or more sections, withdrawing the juice after traversing each section, and re-introducing the juice to the next section of the battery by a pump. Vessels for receiving the juice may be interposed in front of the return pumps, and the juice may be treated with various substances in such vessels.

For the purpose of comparison with existing methods, a battery arranged in accordance with the invention and divided into two parts only will be contrasted with the normal method in which one pump or gravity feed tank feeds the whole length of the battery. Other conditions remaining the same, the speed with which the extracting fluid can be forced through a normal diffusion battery depends on the number of cells through which the liquid has to travel and on the pressure difference between the liquid entering the battery and leaving it as raw juice. The maximum speed is therefore attained when a pump, or such gravity feed is used, that the extracting liquid is forced into the battery at the maximum pressure which the construction of the battery permits it to withstand.

If this maximum pressure is maintained, then reducing or increasing the number of cells in circulation at one time will either accelerate or retard the flow of liquid, as each cell of chips represents some resistance to the passage of the liquid.

Under the present invention by dividing the battery into say two sections and allowing the liquid after traversing a section to enter a tank at atmospheric pressure, since the number of cells is halved the resistance of the chips in these cells is approximately halved: the liquid therefore will travel very much faster through them than in the ordinary battery.

The juice is withdrawn from the tank by a pump which introduces it into the first cell of the second half of the battery at this same maximum pressure which the battery can withstand. The flow through the second half of the battery will therefore be very nearly the same as in the first half, and the flow of the liquid therefore through the whole battery will be very much greater than in the normal battery. Since the increased flow removes the sugar from the slices more quickly, the capacity of the battery is increased.

As the final raw juice has always to be concentrated at a later stage of the process, it follows that the greater the number of cells employed in the battery, the greater the saving of steam or other concentrating medium. It follows that an existing battery can be lengthened by employing the new method and a considerable saving in fuel effected.

Treatment of Finely-divided Calcium Carbonate (Re-use of Carbonatation Scums). Holly Sugar Corporation, of Colorado Springs, Colo., U.S.A. 534,500. November 1st, 1939; convention date, November 5th, 1939.

Through the present invention the carbonatation scums (lime-cake) instead of being discarded may be re-burnt and the calcium oxide (CaO) and carbon dioxide (CO_2) resulting may be re-used in the process again with consequent economy. As the scums (calcium carbonate) are in the state of an extremely fine powder, they cannot be successfully treated in the vertical kilns at present used in the beet sugar industry for the calcination of the limestone.

According to this invention, therefore, the predried scums are calcined in a multiple-hearth furnace, embodying both muffle type hearths and direct-firing hearths, giving gases which are satisfactory for the carbonatation process. In fact, the gases being too concentrated have to be diluted with air to give the mixture customarily used in the carbonatation tanks. As for the calcium carbonate ($CaCO_3$), this becomes fully burnt to CaO.

Moreover, the invention is additionally applicable to the burning of limestone "spalls," that is particles of limestone in its natural state of fineness, such as is not capable of being burnt in the ordinary vertical kiln. For example, limestone in its natural state up to about $\frac{3}{8}$ in. mesh may be calcined by this process, and the calcium oxide thereby produced used in the sugar manufacturing process.

Claim 1: A process of treating finely divided calcium carbonate material which may be in the form of lime-cake derived from the production of sugar from sugar beets, which comprises calcining said material in an indirect fired hearth or in both direct and indirect fired hearths, diluting the carbon dioxide derived from the material to produce a concentration appropriate for the carbonatating of beet juice and applying said carbon dioxide to the carbonatation of beet juice.

1 See also U.S. Patent 2,194,164; *I.S.J.*, 1940. p. 224.

UNITED STATES.

Manufacture of Beet Sugar (Three-Massecuite Process). GEO. E. STEVENS (assignor to THE WESTERN STATES MACHINE Co., of New York). 2,217,603. October 8th, 1940.

In the conventional practice of beet sugar manufacture for the production of white crystals, about 10 or 15 per cent. of the non-sugars present in the starting material are continually re-introduced into the head of the process with the melted raw sugar so that the work of segregating these non-sugars must be repeated and relatively large volumes of massecuites must be boiled in order to obtain a given yield and quality of product. Moreover, the quality of the product obtainable from the white pan boilings is definitely limited. If the purity of the white massecuite is made to exceed about 92° in an effort to raise the quality of the white sugar, the intermediate and the raw massecuites become correspondingly higher than usual in purity and the final molasses purged from the raw massecuite contains so much sugar that net yields are reduced to a point rendering the process less economical.

The preferred embodiment of this invention to overcome these defects is an improved 3-massecuite process, including a high purity, or white, stage which yields the marketable product—white sugar—an intermediate stage, and a low purity, or raw, stage which produces the end material, final molasses. The purity of the white massecuite is raised above normal by boiling it from the thick-juice entering the process, to which has been added a large amount of melted sugar, of considerably greater purity than the white massecuite, and a "high white" run-off fraction from the white centrifugals, of controlled purity substantially as great or greater than the white massecuite. A sharp separation is made between centrifugal run-offs in the purging of the white massecuite so as to produce controlled purity "low white" and "high white" run-off fractions. The "low white" fraction is used as the principal material for the intermediate stage of the process.

The intermediate massecuite is regulated and kept at an abnormally low purity in relation to the purity of the white massecuite and at the point best suited for the production of a low-purity material for the crystallizer massecuite boilings by fractionating the run-offs obtained in purging the intermediate massecuite into controlled "high intermediate" and "low-intermediate" fractions and returning the higher purity fraction to the intermediate pan storage tank for combination with the "low white" fraction. The "low-intermediate" fraction represents the optimum available drop from the controlled intermediate massecuite purity and is passed to the raw pan for the production of crystallizer massecuite of desirably low purity. The treatment of the crystallizer massecuite is carried out under uniform and accurate control so as to yield raw sugar of extraordinarily high purity and separate centrifugal run-off fractions, one a "high raw" fraction of about the same purity as the "low intermediate" fraction, which is combined with the latter to form the liquor for crystallizer massecuite boilings, and another a final molasses of optimum low purity. Reference is made to the process and apparatus described in U.S. Patent No. 2,086,951,[1] and generally to the centrifugal apparatus and processes which have been developed by EUGENE ROBERTS and described in his issued patents.[2]

Purifying Liquids with Active Carbonaceous Colloids. PIETER SMITS (assignor to N.V. OCTROOIEN MIJ. "ACTIVIT," of Amsterdam, Holland). 2,221,683. November 12th, 1940.—Claim 1 reads: In the purificat on of impure liquids, the process which comprises contacting a liquid to be purified with a solid purifying agent, selected from a class consi ting of insoluble calcium and aluminium compounds, n the presence o' a small amount o' a carbonaceous zeolite, formed by the destructive dehydration of a carbonaceous material with a strongly dehydrating chemical, selected from a class consisting of sulphuric acid, phosphoric acid and zinc chloride.

Manufacturing Sugar. VOLKMAR KLOPFER, of Dresden, Germany. 2,243,381. May 27th, 1941.—Claim 1: In the process of preparing sugar, the steps of adding to sugar, containing previously added dry organic minerals, a solution of potassium phosphate in amount sufficient to moisten it yet insufficient to dissolve it, then adding as a fine powder form to said moistened sugar an organic mineral comprising the minerals normally present in beets in the proportions in which they naturally occur with an excess proportion of calcium having a compounding ratio approximating that of the salts of beet and the metallic elements thereof associated with acids which are consumable in the human organism.

Centrifugal Machine. PIETER VAN RIEL (assignor to N. V. MACHINEFABRIEK "REINEVELD," of Delft, Netherlands). 2,243,366. May 27th, 1941. Claim 1: In a centrifugal machine, a motor, a shaft, an imperforate cylinder, a perforated basket having a hub portion mounted on the hub of the cylinder, the wall of the cylinder and basket being spaced to provide an inlet passage, an inlet pipe substantially in line with the shaft, a hood communicating with the delivery end of the pipe and open to said space to deliver material within the cylinder and exteriorly of the basket, and a drain pipe movable to and from the space between the cylinder and basket, said drain pipe when within the space forming an operative drain from said space through the pipe, said pipe when beyond the space preventing such drain.

[1] *I.S.J.*, 1938, p. 41. [2] Consult the *I.S.J.* Patents Index from 1937 to present date.

Stock Exchange Quotations of Sugar Company Shares.

LONDON.

Company.	Quotation August 20th 1941		Quotation July 21st 1941		1941 Dealings Highest.	Lowest.
Anglo-Ceylon & General Estates Co. (Ord. Stock) ..	23/3 — 24/6	..	24/0 — 25/6	..	25/3	— 24/3
Antigua Sugar Factory Ltd. (£1 Shares)	⅜ — ⅝	..	⅜ — ⅝	..	11/3	— 8/9
Booker Bros., McConnell & Co. Ltd. (£1 Shares)....	2⅜ — 2⅝	..	2⅜ — 2⅝	..	52/6	— 47/6
Caroni Ltd. (2/0 Ord. Shares)	1/3 — 1/9	..	1/0 — 1/6	..	1/6	— 11¼
(6% Cum. Pref. £1 Shares)	21/0 — 22/0	..	21/9 — 22/9	..	22/6	— 20/3
Gledhow-Chaka's Kraal Sugar Co. Ltd. (£1 Shares)..	1 3/16 — 1 5/16	..	1 3/16 — 1 5/16	..	24/6	— 22/0
Hulett, Sir J. L. & Sons Ltd. (£1 Shares)	27/0 — 28/0	..	25/9 — 26/9	..	27/9	— 22/1½
Incomati Estates Ltd. (£1 Shares)	⅛ — ¼	..	3/16 — 5/16	..	4/0	— 3/6
Leach's Argentine Estates Ltd. (10/0 units of Stock)	5/9 — 6/3	..	5/9 — 6/3	..	6/6	— 5/0
Reynolds Bros. Ltd. (£1 Shares)	36/0 — 38/0	..	36/0 — 37/0	..	38/0	— 32/7½
St. Kitts (London) Sugar Factory Ltd. (£1 Shares) ..	1⅝ — 1⅞	..	1⅝ — 1⅞	..	35/0	— 34/3
Ste. Madeleine Sugar Co. Ltd. (Ordinary Stock)	14/9 — 15/9	..	13/6 — 14/6	..	14/9	— 11/9
Sena Sugar Estates Ltd. (10/0 Shares)	5/9 xd 6/3	..	5/9 xd 6/3	..	6/6	— 4/0
Tate & Lyle Ltd. (£1 Shares)	54/6 — 55/6	..	53/3 — 54/3	..	55/3	— 46/0
Trinidad Sugar Estates Ltd. (Ord 5/0 units of Stock)	5/6 — 6/0	..	5/3 — 6/3	..	5/7½	— 5/0
United Molasses Co. Ltd. (6/8d. units of Stock)	26/6 — 27/0	..	24/4½— 24/10½	..	26/4½	— 21/9

NEW YORK (Common Shares).†

Name of Stock.	Par Value.		Closing Price June 30th, 1941.		1941. Highest for the Year.		Lowest for the Year.
American Crystal Sugar Co..................	No par	....	16¼	..	17¼	..	9½
American Sugar Refining Co.	$100	....	16¼	..	19	..	13
Central Aguirre Associates	No par	....	16	..	22¾	..	15½
Cuban American Sugar Co.	$10	....	4¾	..	5¼	..	3½
Great Western Sugar Co....................	No par	....	24⅜	..	26⅝	..	19⅞
South Puerto Rico Sugar Co.	No par	....	14¼	..	21	..	13

† Quotations are in American dollars and fractions thereof.

United States, All Ports.

(Willett & Gray)

	1941 Long Tons.		1940 Long Tons		1939 Long Tons.
Total Receipts, January 1st to July 5th................	2,816,621	....	2,095,894	....	2,155,565
Meltings by Refiners " "	2,394,600	....	1,998,416	....	1,993,273
Importers' Stock, July 5th	145,654	....	85,314	....	53,080
Refiners' Stock " "	543,062	....	448,733	....	309,194
Total Stock " "	688,716	....	534,047	....	362,274
	1940		1939		1938
Total Consumption for twelve months	5,712,587	....	5,648,513	....	5,604,051

Cuba.

(Willett & Gray)

	1941 Spanish Tons.		1940 Spanish Tons.		1939 Spanish Tons
Carry-over from previous crops........................	1,184,393	....	588,293	....	729,172
Less Sugar for Conversion to Molasses	71,105	....	— —	....	— —
	1,113,288	....	588,293	....	729,172
Authorised Production	2,400,000	....	2,753,903	....	2,696,517
	3,513,288	....	3,342,196	....	3,425,689
Exports since January 1st	1,604,485	....	1,374,049	....	1,453,988
Stock (entire Island) July 5th	1,908,803	....	1,968,147	....	1,971,701

The Market in New York.

Owing to currency restrictions we no longer receive cabled information giving details of the American market but the following general review may prove of interest to readers.

The "World" market as reflected in the No. 4 Futures Contract in New York has registered a considerable advance during the past two-and-a-half-months, the primary factors being the continuance of tension in the Far East and the fear that the United States may become involved in hostilities. Such a contingency has naturally brought to the fore the question whether sugar shipments from the Pacific exporters could be maintained and the possibility that these might be interfered with resulted in some speculative buying in the U.S. Domestic market. In order to counteract the tendency for rising prices, the Administration increased the U.S. domestic quotas three times within a period of two months, the latest increase taking effect on July 29th, when the various allotments were :—

	Long tons	Initial Quota Long tons	Difference
Domestic Beet	1,719,195	1,383,837	+335,358
Domestic Cane	397,321	375,149	+22,172
Hawaii	887,073	837,533	+49,540
Puerto Rico	885,147	712,484	+172,663
Virgin Isles	9,889	7,961	+1,928
Philippines	877,378	899,045	—21,667
Cuba	2,120,403	1,668,803	+451,600
Foreign sugars	252,553	23,059	+229,494
	7,148,959	5,907,871	+1,241,088

It will be noticed that the Philippines suffer a reduction in their quota figure but this is entirely due to the fact that they had previously renounced part of their quota in order that their shipments to the United States should not exceed the quantity permitted to enter free of duty under the Independence Act. The point which we wish to stress, however, is that, quite apart from sales to the world market, Cuba's export potential has increased, by 451,600 tons, to 2,120,403 long tons. Furthermore, according to press reports, the United Kingdom Government have effected some purchases over the past two or three months, the total quantity being estimated at something over 400,000 tons. With the 1941 Cuban production at 2,434,320 long tons it will be seen that there has been an enormous improvement in the statistical position so far as Cuba is concerned. Following a lengthy period when the price in the No. 4 Contract for the nearest quotable month had hovered around 0·80 c. f.o.b., prices have more than doubled themselves since the early days of June, the peak so far being reached on the 21st August when 1·88 c. was quoted for September delivery. As is usual the rising market has attracted some outside speculation, with the result that there have been some rather wide movements at times.

In a determined effort to prevent internal prices rising, the United States Administration, in addition to the quota increases, established on the 12th August a maximum price of 3·50 c. c.i.f. duty paid and are also stated to be considering a maximum price for Refined. The price of 3·50 c. c.i.f. is equivalent to about 2·10 c. f.o.b. for Cubas and about 1·12½ c. f.o.b. for foreign sugars, subject to freight variations. According to reports, however, the Cuban Planters Association are considering the prohibition of the sale to the U.S. of 405,720 long tons special financed sugars produced this year and propose to dispose of this quantity in the world market as originally intended. There is also some suggestion that Cuba may set a minimum price of 3·70 c. on exports to the United States but in the meantime the Spot price remains nominally unchanged at 3·80 c.

We understand that the general quotation for Refined is now 5·05c.

C. Czarnikow Ltd.

London, E.C.3.
22nd August, 1941.

Alcohol in Brazil.—For the 1940-41 year the production of alcohol for motor fuel in Brazil amounted to about 60 million litres, i.e., roughly a 50 per cent. increase over the previous year. For 1941-42 it is estimated at 80 million litres.

Egyptian Sugar Production.—According to Lamborn, Egyptian sugar production during the year 1940-41 is calculated at 172,000 long tons, raw value, as compared with 153,000 tons in 1939-40. Egypt's home production, which is controlled by one company under Government regulation, is sufficient to supply the local requirements, these in 1940 amounting to 150,000 tons. There is also an import and export trade, raws being imported from Java, refined locally, and re-exported to the Sudan, Palestine, Iraq, and other Near East destinations. During the year ended October, 1940, the imports amounted to 86,000 long tons of raws, while the exports of refined reached 101,000 tons.

Japanese 1940-41 Sugar Crop.—According to Lamborn, production of sugar in Japan, including Formosa, was estimated, at mid-July, at 996,000 long tons, raw value, which compares with the original estimate of 1,176,000 tons and with 1,321,000 tons produced in 1939-40. This drop of 180,000 tons in the year's estimates is due to adverse weather conditions and to typhoon damage in Formosa.

Russian Sugar Production.—Beet sugar production in Russia for the 1940-41 campaign is put by Lamborn at 2,645,000 long tons raw value, an increase of 129,000 tons over 1930-40. There are approximately 190 beet sugar factories in Russia proper, most of them in the south-western corner of the country bordering on Rumania. The 1940-41 output includes the production in that part of Poland taken over by Russia in 1939, in the Rumanian provinces of Bessarabia and Northern Bukovina, and in the district of Antrea (formerly in Finland).

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Notes and Comments.

The War.

During the past few weeks the main struggle against Germany has continued in the East where the Russians have had to face in the north a desperate and bloody assault on Leningrad and in the south have lost further ground in the Ukraine and, as we write these lines, have had to abandon the important city of Kiev, while the Germans, having crossed the lower reaches of the Dnieper, are reported to have reached the shores of the Sea of Azov, thus cutting off the Crimean peninsula from the Russian mainland. Only in the central sector of the vast front do the Russians appear to have held up the assault which otherwise would approach nearer to Moscow.

The German attack on Leningrad has been facilitated by their previous overrunning of Estonia along the Baltic coast and also by the presence of a Finnish army in the Karelian isthmus to the north, which detains a considerable Soviet force to bar its way. Leningrad (the one-time St. Petersburg) is a city of several million inhabitants with large manufacturing interests and is a very considerable source of munitions for the Russian armies, so its capture at an early date is a feature of Nazi strategy. Fortunately, after several weeks of assault, the Germans are finding the defences such a tough proposition that they seem to be still some 10 miles from the centre and are faced with the slow task of battering in the lines of defensive positions one by one if they can.

In the centre the Russians have made major counter-attacks in the Smolensk area and driven the the Germans back to the gates of that town. But even here the record of achievement, so far as it is known, lacks the decisiveness of full success and it must be assumed that the Nazi legions have met with no more than a major check to date, and that their centre army is intact though held up. In the south, however, the big German drive across the Ukraine has made steady headway and the Russian industries in the Donetz basin and further east are brought into imminent danger unless the Russian reserves can stem the tide. Whether the German armies will persist in driving on to the Urals or will turn south in due course in an attempted attack on the Caucasus remains to be seen. Probably the latter is the more likely in view of the lure of the oil wells, but the route to the Caucasus for the Germans does not lie as the crow flies from their present advance positions north of the Crimea. On land they have to skirt the big Sea of Azov pending their capture of the whole of the Crimea, so the road to the oil wells seems still an arduous one. But even the Germans themselves admit that their main task is not territorial acquisition but the destruction of the Russian armies; and this they have not so far succeeded in doing, as the Russian forces have as a rule retreated intact with only proportional losses, while destroying all the towns and villages abandoned.

But whatever the state of their main armies, the Russian reserves of armed men are still numbered by millions; but to put these to the best use they need a proportionate amount of fresh guns, tanks and aeroplanes; and unfortunately not only have they lost in their retreat very considerable amounts of such material but, what is worse, have had to abandon considerable tracts of manufacturing activity. The consequence is that Russia's powers of resistance in the long run now rest on the ability of Great Britain and America to replenish her arsenals. The winter is slowly approaching and should give some breathing space to the Soviets if they do not in the next few weeks have to abandon further manufacturing territory and important key points. But the geographical approach to Russia bristles with difficulties, whether one considers the northern one via Archangel (soon to be frozen up), the long route from Vladivostock, or the newly acquired route through Iran; the Black Sea route is not practical politics. As for the journey to the Persian Gulf from England, it is a voyage of some 12,000 miles, and hardly less from America. What help we and America can give seems, then, largely a long term policy which may bear fruit next Spring but cannot affect the immediate operations, apart from some early dispatches of aircraft.

Nevertheless, the most urgent policy of the Allies and their American helpers is now declared to be the diversion to Russia of all the supplies that can possibly be spared, and so our country is faced with the stern necessity of turning out at the highest pressure possible the needed arms and munitions, the planes and the mechanized vehicles, during the coming winter months. What other plans our supreme command have in view to easen the strain on Russia is known only to them. England is an armed camp, temporarily unable to use its large and well equipped forces, save to resist an invasion which seems on the face of it probably postponed till Russia has been dealt with. Ultimately, this large army seems destined for land operations against the Germans, but till it is considered strong enough to make the attempt, an invasion of Western Europe, in the light of the results of German fighting technique in the East, offers risks that may well be deemed too hazardous for premature exploitation, though to the uninitiated the present moment when the Germans are so busy along the Russian front seems to offer an opportunity for a counter-attack in the west that may never again present itself. Nevertheless, a false step taken now might have very far-reaching repercussions. In the Middle East, the Allied forces are said to number three-quarters of a million men with ample equipment and a considerable air force. Whether this army will be used to attack and drive back the appreciable Italo-German force quartered in Libya and threatening Egypt, or will form a British expedition to the Caucasus, to assist the Russians, remains to be seen; but either move must be an obvious and desirable possibility in the near future. The successful elimination of German influence in Iran and the consequent opening of that country for Allied transport has been a valuable preliminary operation.

The United States continues to show increasing practical interest in the momentousness of the struggle against Nazism. The American Navy is now authorized to take more active steps in the Atlantic in resisting the activities of German raiders and submarines. The isolationists who have had a long innings seem at long last to be a declining force, as the vast majority of the Americans are coming to realize fully the dangers to their own country and its democratic institutions of this vast enslavement of Europe and its manufacturing resources—all mustered under compulsion to further the ultimate designs of the Herrenvolk to conquer the world. One only hopes the dawn of realization in America has not come too late to render help while the going is still reasonably good.

Alcohol Production Plans in Australia.

A Committee of Enquiry dealing with the question of providing power alcohol in Australia for blending with petrol to augment the national supplies was appointed some little time ago by the Federal Government, and its report was issued last June. Briefly, the Committee recommended that immediate steps be taken to expand Australia's production of power alcohol to 52½ million gallons per annum, mainly from wheat and sugar cane; that a price of 2s. per gallon wholesale at blending depots be fixed; and that all motor fuel consumed in Australia should be a blend containing somewhere between 12½ and 20 per cent. of alcohol, in which proportions the mixture of petrol and alcohol is at the highest efficiency in the average petrol engine.

The Commonwealth Government after giving the Report full consideration announced that they had decided as a first objective to aim at the production of 22 million gallons of power alcohol per annum, of which seven millions would come from existing anhydrous distilleries; five millions from existing rectified spirit distilleries; and ten million gallons from new distilleries to be erected. The 7,000,000 gallons from the existing distilleries will be produced from molasses supplemented by 44,000 tons of raw sugar per annum, and it is proposed that the new distilleries to produce ten million gallons will use wheat exclusively and will be erected in the southern half of the country. The capital required for their erection is estimated at £1,100,000. Arrangements will be made for the total output of power alcohol to be distributed through the Oil Industries Cartel at prices to be fixed by the Commonwealth Prices Commissioner.

It will be noted that the Federal Government does not propose to include Queensland in its emergency distillery building programme. This is a matter of some disappointment to the sugar industry of that State which has already, through private enterprise, provided an outlet through a number of distilleries for some of its excess molasses and has some good claim to a share of the new Government erection of distillery capacity. As it is, the existing distilleries at Sarina, Pyrmont and Yarraville will continue to use molasses supplemented by up to 44,000 tons of sugar a year, a figure in the vicinity of 9 per cent. of the production for export. The view of the Queensland sugar producers is that they should be allowed to erect additional distillery capacity to handle sugar juices and it is suggested that an additional four million gallon capacity be authorized, absorbing a further 30,000 tons of sugar. The sugar industry is particularly concerned at the moment with the question of finding alternative uses for its surplus sugar in view of the uncertainty prevailing as to the ability of the customary overseas markets to ship the normal sugar exportation to its destination. The Federal Government, however, seem to hold the view that the quantity of alcohol turned out must bear some relation to the existing wartime rationing of petrol in the Commonwealth, and this probably explains why they are unwilling at the present time

to give Queensland facilities for turning out more. After the war, the problem will doubtless take on a fresh aspect, but will naturally depend on the prospects of a steady market overseas for the excess sugar.

From the technical and economic point of view the claims of the Australian cane sugar industry to consideration in respect to distillery location and raw material used are respectable. They claim that alcohol made from sugar juices in Queensland and tankered to the southern cities can compete with alcohol made from any other raw material including wheat. Actual production costs using sugar juices are cheaper than from any other material and it is only the fact that the raw material or the alcohol has to be transported inter-State which enables wheat to compete at all. Then again, an alcohol distillery built alongside a sugar mill needs far less construction than a wheat distillery, which latter in addition needs complete boiler plant and crushing, cooking and malting apparatus. The sugar distillery can likewise be constructed much more quickly.

Indian Production Estimates.

The second official forecast of the production of sugar direct from cane in modern sugar factories in India during the 1940-41 season, as published last June, put the total quantity at 1,082,500 tons sugar as compared with the actual quantity of 1,241,700 tons in 1939-40. Production in the U.P. and the Bihar is expected to yield only 755,600 tons, as compared with 981,600 tons in 1939-40, the reason being that in those provinces cane sugar production has been restricted by means of crushing quotas, based on a total production of 720,000 tons assuming the recovery to be 9·5 per cent. The actual recovery is expected, however, to reach 9·9 per cent., hence the larger output that will actually be achieved. In other provinces of India where no restrictions apply, the estimated production in 1940-41 is expected to be 327,000 tons, as against 260,000 tons actually produced in 1939-40, an increase of over 25 per cent.

The recovery of sugar per cent. cane for the whole of India is estimated at 9·75 ; this constitutes a new high record, comparing with 9·45 in 1939-40, and is chiefly due to the very high recoveries obtained by factories in the United Provinces and Bihar. The number of factories at work is put at 147, or two more than in 1939-40. Of these, four are new factories, one each in U.P., Madras, Punjab and N.W. Frontier Province. The majority of the Indian factories commenced working by the end of December and closed down by the middle of April last.

Alvaro Reynoso.

Some notes were recently published on the life of the celebrated agronomist ALVARO REYNOSO,[1] who was actually a notable investigator of his time in several different branches of science. He was born in Cuba in 1829 on a coffee plantation hard by Guanimar, the son of Spanish parents. He graduated as B.Sc. at the Royal University of Havana, at the early age of 17, following which he went to Paris, where he entered the laboratory of the famous chemist, PELOUZE. At the same time he pursued his studies at the University. Even as a student he carried out some remarkable original work, some of which was published by the French Academy of Sciences. One may mention his investigations on the detection of iodine and bromine in association with each other, on several new combinations of ammonium with ferrocyanides, and on the presence of sugar in urine, especially that of hysterical and epileptic patients. He finished his university studies with the presentation of a thesis on the formation of ether, which was published by the Academy, and for which he was awarded his doctorate in 1856.

In the following year he was made professor of chemistry at the University of Madrid, but he occupied this chair only for a short time, desiring to return to his native country. In 1858 he was appointed to the professorship of chemistry at the General School of Havana, and shortly after this he threw himself enthusiastically into the application of science to the cultivation of sugar cane. This work was crowned by the publication of his classical "Ensayo sobre el cultivo de la caña de azúcar" in 1862, which produced a complete revolution in the methods of most countries growing cane.

Later, he carried out experiments on the cultivation of coffee, tobacco, corn, rice, etc , and reported on the value of guano as a fertilizer in combination with nitrogenous compounds under Cuban conditions of cultivation. About this time he aspired, though with less success, to improve the existing methods of sugar manufacture, and was the inventor of a system of cane juice defecation, using aluminium phosphate. He also conceived of a system of eliminating water from the purified juice by freezing.

Another direction into which REYNOSO's activities led him was the field of medicine, in which he carried out some notable investigations into the nature of the secretions of the glands of the human body. He was among the first to point out the function of the thyroid, as it is understood at the present day. This would be about the year 1872, when he was at the peak of his career.

His later life was less happy, as about 1875 he had been deprived of his professorship as the result of the vicissitudes of Spanish politics. He was subsequently obliged to engage in Europe in the exploitation of patents for the preservation of foods, using compressed gases (as nitrogen and carbon dioxide), and in similar business engagements, remaining in Paris until about the year 1883. In that year he returned to Cuba to assume the position of Royal Commissioner of Agriculture. He died in 1888.

[1] By ISAAC CORRAL in *Proc. 14th Conf. Assoc. Sugar Tech. Cuba*, pp. 351-359.

The Varietal Position in Jamaica.

In 1932 was established the British West Indian Sugar Cane Breeding Station. The problems it was set to solve were none of the easiest. Situated in one of the Islands, and that one in which, owing to the nature of the soil, the absence of any high altitudes and the uniformity of the climate, is scarcely typical of the conditions under which sugar cane is for the most part grown in the islands generally, it was faced with a series of problems capable of solution only indirectly. Preliminary selections had to be made by interpolation, by estimation of the probable behaviour of a variety under a certain set of conditions from its behaviour under a different set. It is not an insoluble problem; a similar condition faced India when, with the establishment of the Station at Coimbatore, Madras, the raising of canes for the cane growing areas of Northern India was undertaken. The success there achieved is capable of repetition and it is dependent on two things, the identification of characters and behaviour which, under the one set of conditions, are indicative of adaptation to the other and, since so many of these are too subtle for direct measurement, a certain flair in the selector. Both these are only to be acquired with time and the nine years of the life of the Station is none too long for such a purpose, nor the physical work of preliminary selection and later trial in the particular island for which the varieties are intended. As the most recent survey of the canes commercially grown, that for 1938-39,[1] shows, no product of the Central Station has yet reached commercial production in Jamaica but this by no means implies that nothing has been accomplished. The accomplishment to date is given in a recent publication by A. E. S. McIntosh,[2] Geneticist to the Station, in which he records the results of his observations during his third visit to the Island.

The dominant cane in Jamaica is BH 10/12 and its susceptibility to mosaic makes the problem of that disease the major issue. Though varying in intensity from place to place, it occurs throughout the Island and there are indications that it exists in two, and possibly three strains. While a measure of control is possible, such control is difficult to enforce especially where a considerable portion of the crop is raised under a peasant system, and the ultimate remedy is the introduction of one or more varieties resistant to mosaic. This limitation to a variety possessing resistance to mosaic somewhat cramps the breeder's form since such resistance is not too widely distributed among varieties and must be combined with the other excellent characters of BH 10/12 if it is to be acceptable.

From the aspect of mosaic and the question of breeding varieties resistant to it, Jamaica may be divided into four regions; good soils with heavy or light mosaic infestation and poor soils similarly sub-divided. At the present time BH 10/12 is standard on the second and POJ 2878, gradually being replaced by FC 916 and M 28, on the first. POJ 2727 and Co 281 characterize the third and Co 281 the last. In addition, therefore, to the problem of mosaic resistance, is the problem of replacement of what are termed these four makeshift varieties now grown on poorer soils.

Up to August, 1940, 63 seedlings had been introduced, of which 18, belonging to the series B 29 to B 35, were of noble origin and the remainder, of the series B 31 to B 37, nobilizations. Of the seven introduced, in 1936, B 3439 (Ba 11569 × Q 813), a noble cane with an unusually high resistance to mosaic as such, has given exceptionally promising results as a plant cane but its ratooning reactions are not fully determined. B 3013 (Ba 11569 × ?) promises well for good soils where mosaic can be controlled. In 1937 a batch, the first of its kind and embracing ten seedlings, of nobilizations was introduced. Of these B 34104 (Co 281 × BH 10/12) has proved an excellent cane adapted to a wide range of conditions and a good ratooner but very susceptible to mosaic, though possibly tolerant. Its extension raises, therefore, the question of policy; whether the ultimate aim is to eliminate mosaic entirely so that, after a period of resistant canes, the ground may be cleared for re-establishment of susceptible varieties. If this be so, there is no room for even a tolerant variety. Of the remainder only B 34117 (POJ 2727 × Co 281) and B 3172 (POJ 2727 × BH 10/12) are considered worthy of further trial.

In 1939 further introductions were made, partly of noble canes and partly nobilizations. Full information about these is not at present available but, of the 11 noble canes, five have been discarded owing to poor growth or susceptibility to mosaic. Of the 29 nobilizations, five have similarly been discarded. Special attention was paid, however, to two; B 3254 (POJ 2725 × B 417) and B 35187 (B 3172 × B 391). The former is an adaptable cane likely to do well on poor soils, the latter a mid-season cane for good soils. Of the latest batch, all nobilizations, introduced in 1940 it is too early to speak.

It is suggested that the time has come for the standardization of the methods for testing the seedlings with the object of early elimination of unsuitable varieties, and a scheme through nurseries, mosaic resistance tests, observation plots and variety trials is outlined. Finally the difficult problem of cane farmers and small settlers is discussed. The former sells to the factory and can be controlled through it. The latter also manufactures wet sugar and uses his cane for chewing and fodder. The organization of the issue of certain of the hardier of the new varieties to him is recommended.

H. M. L.

[1] *I.S.J.*, 1941, p. 312. [2] *B.W.I. Central Sugar Cane Breeding Station, Bull.* 22 (1940).

Some Gleanings from the South African Congress, 1941.

Insects and Sugar Cane.

The sugar cane has long been cultivated in Natal and appears to have been already introduced by 1635[1]; it is not indigenous to the country. Subsequent to 1847 numerous importations had been made, among them Uba in 1883, before any system of quarantine was established. It must be a matter of congratulation to the cane farming community, therefore, that the country has escaped any serious insect attack. If, however, rigid quarantine has minimized the risk of the introduction of pests, it cannot guarantee a 100 per cent. immunity nor can it be forgotten that the changed environment caused by extension of cultivation, change in the varieties cultivated and so on may lead some indigenous insect, formerly of small economic importance, to develop in epidemic abundance. It is desirable, therefore, that a continuous check should be kept on the position, of which a review is given by J. Dick.

After a brief general account of the insect pests attacking cane in other countries, the author reviews the insects so far found to be causing damage to cane in South Africa. Among the Hemiptera, *Aphis maidis* is important as the main vector of mosaic but does not occur in large numbers on cane. *Aphis sacchari* and *Pseudococcus sacchari* may be numerous and potential pests. Perhaps the most important Hemipterous insect is the Jassid *Cicadulina mbila* owing to the fact that it is the vector for streak disease. The Delphacid, *Perkinsellia saccharicida*, a leaf hopper, is occasionally found and is potentially dangerous, having been one of the most serious Hawaiian pests, though now controlled by the Caspid bug *Cyrtorhinus mundulus*. Of Orthoptera, the red locust, *Nomadacris septemfasciata*, is undoubtedly the most serious pest at the present time, though outbreaks are sporadic. The only other insect of this group is the grass hopper *Zonocerus elegans* but thought unlikely to become a pest.

The Lepidoptera include the borers *Sesamia calamistis*, more common on maize, sorghums, reeds and grasses than on cane, and *Eldana saccharina* which appears to be located in the Umfolozi area. The army worm, *Laphygma exempta*, is responsible for occasional severe outbreaks. Of Coleoptera *Heteronychus licas* is responsible for outbreaks on the Umfolozi flats as well as in Portuguese East Africa.

Rapid Estimation of Plant Foods.

With the extension of the use of fertilizers the question of cost forces a growing attention to their economic use. A primary requirement is a knowledge of the pre-existing amounts of available plant food in the soil and, in view of the diversity which commonly occurs even within a single field, the distribution of this. It is no uncommon experience to find more or less well defined gradients of the more important plant foods and a single composite analysis can, under these circumstances, afford only a very rough guide to fertilizer requirement and fertilization on such a basis may well lead to the use of an excessive amount of fertilizer or, conversely, to the application of too low a dressing. The present tendency is, therefore, to multiply the number of analyses so that some indication of these gradients may be traced. The ultimate objective would be a system of differential fertilization under which the fertilizer application would be varied through the field thus compensating for the natural gradients. The initial requirement here, in view of the large number of analyses involved, is more rapid methods for analysis than those commonly employed. That is the basis of the rapid chemical methods (R.C.M.) of Hawaii. There is not required from them the same degree of accuracy as is demanded of the more detailed methods, it is merely necessary to know whether the available amount of any particular plant food lies between certain limits indicative of certain values of dressing. Work on the standardization of such quick methods is proceeding in many countries and B. E. Beater records a series of methods for the evaluation of nitrogen, phosphoric acid and potash, giving details of analytical procedure and preparation of standards.

Organic Manures, Composts and Artificials.

G. Ingham discusses the relative advantages of organic manures, composts and artificial fertilizers, and the conclusion he draws is that artificials are not inferior to farmyard manure, have no harmful effect on the soil or the nutritive value of the crop and do not render the crop susceptible to the attack of insect or fungus. Composts are held to be much inferior to farmyard manure while the cost in labour may easily exceed the value of the product based on analysis.

It must be confessed that these conclusions are based on little definite evidence other than the century-old experiments of Rothamsted. On the other hand, much of the recent work is ignored, whether it be technical experience or practical application. Thus recent indications as to the importance of mycorrhiza are not mentioned nor the cumulative evidence of the medical profession that the nutritive value of the product is affected. The reaction of the soil in British Guiana hardly justifies the statement as to the absence of harmful effects of fertilizer on the soil nor do the numerous instances of compost increasingly produced on a commercial scale for tea and other estates exactly harmonize with the statement that the task of making compost is one beside which the labours of Hercules fade into insignificance.

H. M. L.

[1] *I.S.J.*, 1940, p. 378.

The Fight against the Borer in Barbados.

Barbados possesses certain peculiarities which make any biological control of the pests of the sugar cane an exceedingly difficult problem. In the first place the cane cutting season is a well defined one and leads to a period when the fields are practically bare of cover such as the parasite needs for its survival. In the case of the borer, *Diatraea saccharalis*, this break is less harmful for it can find ample cover within the residues of the crop and a sufficient population is thus carried over to the following season. In the second place, this densely populated island is practically denude of wild growth such as might, and does in other countries, form a natural reserve in which the insect may find the protection it requires during the dead crop-season. Here the dead season may last from two to four months according as the rainy season breaks early or late and it is a period when the cane cover is too light to afford the necessary environment, the relation between which and the multiplication of the parasite, is known to be a question of delicate adjustment, especially in the matter of light intensity and mating. Thus Barbados has come to rely on mass artificial rearing and seasonal liberations of the egg parasite, *Trichogramma minutum*. Efforts have not, however, been neglected to find an accessory parasite and *Lixophaga diatraea* was introduced in 1930 and again, on an extended scale, in 1934-35. That parasite failed to establish itself and, by 1939, large-scale collections of *Diatraea* larvae failed to disclose a single survivor.

Attention was then directed to the Amazon fly *Metagonystylum minense*. This fly had been successfully established in British Guiana and St. Lucia. On the other hand efforts failed to establish it in Antigua and Puerto Rico, in which latter island, however, its artificial rearing and distribution was continued. The relative similarity of the climate of Barbados to that of those islands in which failure had been recorded as opposed to that of those areas in which success had been achieved, made it improbable that success would follow introduction here and the attempt was not made. In 1937, however, S. C. Harland reported a different strain of *M. minense* from the Sao Paulo State of Brazil under conditions more approximating to those of the drier West Indian Islands. It seemed possible that this melanic strain might prove able to establish itself in Barbados and that it was at least worth the attempt. A visit was, therefore, paid to Brazil by R. W. E. Tucker in 1938 to arrange for a supply of the parasite, and an account of his visit and efforts to establish it in Barbados is given under the title "Introduction of Dry Area Race of *Metagonystylum minense* into Barbados."[1]

In this paper the author points out that the climatic similarity is based mainly on the figures for the annual rainfall. A closer study of the climatic conditions points to many differences likely to be, on balance, unfavourable for successful introduction. As a continental tract, Sao Paulo has a much greater range of temperature. Winds, too, are comparatively strong in Barbados, particularly at the critical season when the only cover for the insect, that of the cane fields, is at a minimum. Further, as affecting the practical question of transference, the seasonal sequence of rains and dry weather is reversed in the two areas.

With the decision to make the attempt, a more comprehensive scale than any previous introduction was undertaken. In addition to those from Brazil, introductions of the Amazon strain were made from St. Lucia as well as Puerto Rico, both derived from British Guiana. The melanic strain was also introduced from Puerto Rico, to which island it had earlier been introduced. Two sources in Brazil were also drawn on directly, from Campinas (Sao Paulo) and Vicosa (Minas Geraes). In addition, among the liberations made were crosses between the Barbados and Puerto Rico melanic strain, between the melanic strains from the two sources in Brazil (since these may represent different strains) and between the Sao Paulo melanic strain and the Amazon strain both from St. Lucia and Puerto Rico. Between the two basic strains from the Amazon region and from Sao Paulo, there are certain diagnostic differences summed up in the term melanic applied to the latter. The crosses are intermediate in colour. The fecundity of the wet-area strain (Amazon) appears, too, to be greater than in the dry-area (Sao Paulo) strain. Total liberations up to January, 1940, consisted of 7559 females and 3495 males.

The main account, however, concerns the details of the arrangements for collection, transport and introduction of the Brazil consignments which included also *Paratheresia diatraea*. Numerous difficulties were encountered. A large proportion of the larvae of *D. saccharalis* at Campinas were too small to be parasitized. Further, delay in emergence (one per day from 200 puparia) and the initial preponderance of males (all the first 15 to emerge with the first female on the 17th day), caused considerable trouble, for it rendered the time too short for the rearing for despatch of any large number of puparia free from hyper-parasites. A certain number of direct field collections were, therefore, despatched and checked for hyper-parasites on arrival.

Further difficulties were met with on arrival owing to the lateness of the rains and consequent paucity of *Diatraea* larvae at the right stage. It was too early to draw any conclusions, but no recoveries had been obtained by the end of the year.

H. M. L.

[1] *Agl. J., Dept. Sci. and Agric., Barbados*, 8 (1939,) p. 113.

The Java Sugar Industry in 1940-41.[1]

The Java sugar crop harvested during 1940-41 season was better than anticipated and production, though only slightly more than in 1939-40, was the highest since 1932-33. Local consumption continued to increase, but exports decreased by about 40 per cent. in 1940 and the year-end carry-over was nearly twice the normal one, being 920,478 tons at December 31st, 1940.

Cane is usually planted during April, May and June, and about 15 months elapse between planting and cutting. No ratoons are grown. In view of the long period between planting and harvest, land rental contracts are for eighteen months, three years, or else 4½ years. Land having yielded a sugar crop is planted to other crops for two eighteen-month periods before it is again used for cane.

The production of sugar in Java is directly controlled by the Government, who through the N.I.V.A.S. (Netherlands Indian Association for the Disposal of Sugar) determines planting quotas and controls the sale of sugar as well as prices both foreign and domestic. Under the regulations the Government has to announce before or by November 1st of the second calendar year preceding the crop in question what the production for the latter shall be. However, since actual production cannot be predetermined, surpluses or shortages develop and production figures are modified accordingly.

Production by sorts during the past five years is shown in Table I, the quantities being in metric tons.

TABLE I.

Year	White Sugar Metric Tons	Browns Metric Tons	Total Metric Tons
1936-37	213,006	379,384	592,390
1937-38	755,650	658,850	1,414,500
1938-39	908,876	490,051	1,398,927
1939-40	1,239,517	335,836	1,575,353
1940-41	992,181	612,876	1,605,057

Consumption.—The normal annual consumption of sugar in the Netherlands East Indies is calculated roughly at 325,000 metric tons. Actual figures for the past three years have been as follows: 1938, 321,827 tons; 1939, 320,315 tons; 1940, 347,135 tons. Except for fancy grades such as perfumed aromatic sugars, loaf and powdered sugars, imports are prohibited.

Exports.—Sugar exports from Java were set at 1,050,000 metric tons by the International Sugar Convention, plus approximately 80,000 tons destined for Holland. Consequently Java under normal conditions can expect to export about 1,130,000 tons annually, of which about two-thirds go to Asiatic destinations and most of the balance to Europe. However, for the past two seasons, exports by destinations have been as in Table II.

The carry-over at April 1st under the Convention regulations is not allowed to exceed 500,000 metric tons. The actual figures of carry-over for the past four years have been as follows:—

	At April 1st Metric Tons	At December 31st Metric Tons
1937	257,000	554,800
1938	309,000	567,600
1939	225,000	470,000
1940	242,000	920,478

Marketing and Prices.—Exporters buy from the N.I.V.A.S. at a price which has no direct relation to the cost of production. This price is a so-called basic Soerabaja warehouse price which is subject to change in accordance with world market conditions and is based upon the price for export to the most expensive foreign destination, usually Singapore. The exporter receives a rebate amounting to the difference between the tentative price he has paid to the N.I.V.A.S. and the approved foreign sales price, when he submits a landing certificate proving that the sugar in question had been delivered to the designated foreign port. The fundamental object of this rebate system is to keep the price of Java sugar as high as possible in each foreign market. To this end exporters are prevented from changing the destinations of sugar purchased from the N.I.V.A.S.

TABLE II.

EXPORTS OF JAVA SUGAR BY DESTINATIONS
(in Metric Tons)

	1939-40 May-Apl.	1940 May-Dec.
Netherlands	133,657	12,976
United Kingdom	23,482	155,207
France	15,074	7,607
Italy	61,124	- -
Germany	200	—
Norway	10,800	—
Balkan States	24,149	4,040
Egypt	101,427	31,174
Morocco	8,416	—
South America	5,876	22,009
Port Said, f.o.	61,861	11,109
Suez, f.o.	263	—
Aden	14,331	1,867
British India	288,098	15,523
Ceylon	92,182	38,258
Japan	622	21
China	25,681	48,696
Hong Kong	112,231	105,692
Singapore	73,672	46,646
Penang	19,913	11,888
Thailand	16,471	13,447
New Zealand	16,686	—
Persian Gulf	91,570	46,257
Other Destinations	312,819	22,008

[1] Abstracted from Industrial Ref. Service (U.S. Dept. of Commerce) Foodstuffs No. 71.

The 1942 *Crop.*—Production for 1942-43 was fixed at 1,450,000 metric tons (crystal value). This production, however, will be curtailed by approximately 122,000 tons, because of excess 1940-41 production. Save for the normal contingencies of growing cane, no additional factors are known which should modify the anticipated production next year of about 1,328,000 tons.

The Australian Sugar Industry in 1940.

Prices and Distribution.[1]

The Australian Sugar Board has made available its figures for the 1940 season, and the following table (I) gives an average for years in the 1920's and the results for the last six seasons. New South Wales sugar is included.

TABLE I.

Average of	Australian Consumption.	Export.	Total Purchased.	Percentage Exported.
	Thousands of tons (of 94 net titre).			
1926-1927-1928	344	143	487	29
1935	337	310	647	48
1936	359	423	782	54
1937	365	445	810	55
1938	364	458	822	56
1939	383	545	928	59
1940	400	406	806	50

Following four years of increasing production to a peak in 1939, which was higher than the average for the stable three years, 1933 to 1935, by 42 per cent., the Australian output of cane sugar fell sharply by 13 per cent. to 806,000 tons in 1940. Queensland's contribution of 759,000 tons represented a decline of 15 per cent. from the 1939 peak. Of the total value of £13·8 millions, this State's share was just over £13 millions, a drop of one million. The tonnage exported in 1940 was the lowest since 1935, the export proportion falling from 59 to 50 per cent. as compared with 1939. Australian requirements increased by 4 per cent.

The prices shown in Table II are those received for raw sugar delivered by the mills at their nearest ports. Both of the 1940 average prices, excluding and including "excess" sugar respectively, were the best since those of the 1932 season. Overall average for individual Queensland mills ranged from £15. 12s. 8d. to £17. 11s. 9d., varying according to the proportion of "excess" sugar, i.e., sugar delivered by the mills in excess of the prescribed "peak" quotas, and paid for at export price only.

The peak quotas, aggregating 737,000 tons of 94 net titre sugar, remained unaltered for the 1940 season, but, as in the previous year, the proclamation acquiring the crop allowed the mills to produce, for marketing at export price, an additional 7 per cent. of their basic quotas. Subsequently, and again as in 1939, an amending proclamation in October provided, in effect, for the acceptance of quantities without limit, thereby permitting the harvesting of the whole of the 1940 crop.

For the 1941 season, a proclamation has been issued acquiring the mill peak quotas without amendment, and, therefore, the aggregate of 737,000 tons. When first announcing, in April, its intention concerning acquisition, the Queensland Government emphasized the desirability of an early commencement of crushing so that advantage could be taken of any shipping that became available from early in June onwards. It was explained that a graduated bonus would be paid to the mills as partial compensation for producing sugar during the months of May and June.

Although no mill was able to commence crushing in May, several signified their intention of doing so during the first week in June. The bonus to be paid has been fixed at 30s. per ton 94 net titre for sugar manufactured and available for delivery from the commencement of crushing up to the 14th June, and 20s. per ton for sugar manufactured from the 15th to the 28th June.

TABLE II.—PRICES PER TON.

	Average of 1926-27-28. £ s. d.	1935. £ s. d.	1936. £ s. d.	1937. £ s. d.	1938. £ s. d.	1939. £ s. d.	1940. £ s. d.
"Home price"	26 12 10	24 0 0	24 2 0	24 0 0	24 0 0	23 12 6	23 1 0
Export price	11 18 2	7 18 9	7 19 0	8 6 0	8 4 3	10 7 6	11 5 6
*Average—							
Excluding "excess" sugar	22 6 1	16 17 0	17 1 4	17 11 0	16 19 1	16 19 7	17 11 9
Including "excess" sugar	22 6 1	16 3 8	15 4 8	15 6 5	15 2 2	15 15 3	17 2 8
Tons of "excess" sugar	Nil	45,422	149,618	183,869	163,943	168,719	58,680

*Applies to Queensland only. The 1940 average price received by the New South Wales mills, to which a higher home consumption quota applies, was £17. 6s. 9d. for a production of 47,031 tons, compared with £18. 14s. 8d. for 36,929 tons in 1939.

[1] Extracted from *Economic News* (May, 1941) through Queensland Cane Growers' Council Circular, No. C 103.

Electric Motor Maintenance.[1]

By THE MACKAY SUGAR MILL ELECTRICAL ASSOCIATION.

The humid conditions found in sugar mills would tend to cause early failures in electrical equipment were precautions not taken to ensure the exclusion of moisture and juice vapours from the windings and bearings. It is becoming common practice to-day to select protected types of motors and to treat each installation on its own merits, realising that the initial cost of a motor is not the only consideration. The careful selection of the position of the motor, with due regard to the proximity to steam and water drains, elevated vessels which may overflow or are washed out at week-ends, heated vessels or those discharging clouds of vapour, will do much to reduce maintenance and increase useful life.

Records.—Some system is necessary wherein the various particulars of motors are recorded so that an intelligent and informative history can be obtained. A card system seems the simplest form and should contain the following headings : Maker's number and frame size ; mill number ; horse power ; speed ; type ; date purchased and installed ; position in mill or distribution box number ; type of drive, including pulley or coupling sizes ; bearing particulars ; name-plate load in amps. ; and the actual working load in amps. A margin should also be left for remarks such as the date of re-winding, the installation of new bearings, varnishing or carrying out of insulation tests, etc.

Cleaning.—Before dismantling, the motor should be examined for bearing play, and for the type of dirt on the windings. The presence of dirt calls for benzine as a solvent but the most common deposit met with in a sugar mill is juice which is water-soluble. For the latter the most favoured method of removal is to wash the windings with a wet cloth and stiff brush, wiping them dry after each application until all stickiness is removed. Another method is to use an engine cleaning gun at about 40 lb. air pressure to blow on a mixture of benzine and water and then to wipe the windings dry. Any air pressure in excess of 40 lb. may cause damage to the installation. Water should be used sparingly as it may contain some corrosive constituent which, although it may be evaporated during the drying process, will remain in the hygroscopic insulating material to cause damage at a later date. A final wash with benzine should leave the winding clean. Dust and bagasse have to be brushed and blown out with air.

Drying-out.—Drying-out requires an oven, either a large one in the workshop or a smaller one of the portable type, which is an advantage where conveyance of motors to the workshop involves a considerable amount of labour. The temperatures reached should not exceed 90°F. and some form of control is necessary for baking varnishes. During drying, insulation resistance tests between phases and to earth are necessary and readings should be kept, as this is the only means of gaining any knowledge of the condition of the windings. The tendency is for the insulation resistance to rise rapidly at the outset, to fall until the moisture is driven off, and finally to rise gradually until a steady high value is obtained. The final reading should be entered on the data card, and a comparison with previous tests gives a good guide to the condition of the winding. Any winding that cannot be dried out to one megohm resistance should be regarded with suspicion and re-tested at short intervals.

Varnishing.—While the motor winding is still hot it should be varnished. Good impregnation can be obtained by standing the winding over a drip tray and pouring on the varnish, brushing it vigorously into the entrance of the slots, first from one side then from the other. The varnish should be well thinned out, usually in the proportion of five parts of thinner to one of varnish. If more than one coat is applied, allow the excess varnish to drain off in one direction for the first coat and the opposite direction for the second coat, so that both sides are sealed. Spraying gives a good finish to the winding, but the varnish does not penetrate to any extent. If a baking varnish is used, three to four hours at approximately 160°F. is usually sufficient for complete drying. When cold, the final insulation resistance should be entered on the cards with particulars, for comparative purposes, of number of coats of varnish, make, baking temperature and time. Oil-resisting black baking varnishes, giving hard finish, are usually preferred.

Ball and Roller Bearings.—These types of bearings have a very long life if given reasonable attention ; wear usually comes from faults such as overweighted pulleys, too great a belt tension, misalignment or the presence of foreign matter. Great care should be taken to cover the bearings when the motor is dismantled and to wash them clean before re-assembling. It is usually advisable to replace a bearing by one similar to the original as some motors have large tolerance bearings to allow for the 40°F. rise permissible in the motor. Wear of bearings is best found by measuring the rotor and stator clearances at top and bottom ; should the difference exceed 10 per cent. of the average measurement a new bearing should be installed as the wear, once started, increases rapidly and the extra running life is rarely worth the chance of failure during a crushing period. In fitting bearings, damage from hammer blows may be avoided by using "pullers" and "presses" and heating the bearings in oil before pressing on the shaft. Care should be taken to ensure that the bearing is hard up

[1] *Proc. Queensland Soc. Sugar Cane Tech.*, 12th Conf., pp. 89-94.

against the shaft shoulders for correct alignment. When filling bearings with grease the spaces within the bearing should be completely filled and the clear spaces in the housings filled to half their capacity. This is sufficient grease for ball bearings for six to twelve months, but large roller races require fresh grease added to the running surfaces at least once during the six months running. Excess grease causes heating and leakage on to the windings.

Two Part and Sleeve Bearings.—Wear on these bearings calls for re-metalling and a rough journal requires skimming up in a lathe. Slip rings and commutators should be checked for truth at the same time. The most common trouble is overheating which may be caused by an unsuitable lubricant, lack of lubricant, insufficient bearing clearance or lack of oil on the high pressure spots. An oil of 30 or 40 S.A.E. rating should serve satisfactorily. Leakage from drain plugs may cause loss of oil and poor seal rings allow escape of lubricant to the windings. Oil rings should be perfectly round and, if any joints are made smooth, the ring will not stick. Bearing clearance is important, and 0·0015 in. per inch of shaft diameter should allow sufficient oil film between wearing surfaces. Oil grooves should receive careful study as to their position and, while providing plenty of oil to the high pressure zones, the grooves should not be cut into this area. A "lead-in" for the oil should be provided on the longitudinal side grooves but the end of the grooves should not be carried too close to the bearing edge.

D.C. Motor Maintenance.—The "drop" test and "growler" are usually used for testing faults on D.C. armatures and, with the insulation resistance to earth, would indicate the condition of the winding. Most faults are made evident by sparking at the brushes and may be traced to one of the following causes: Eccentric or wavy commutator; high or low bars or unseasoned commutator; high mica or soft copper; incorrect brushes, brush settings, or brush holders; or defective fields.

(1) A small amount of eccentricity may not affect the running of slow speed motors, but if the journals are to be skimmed up this defect can be overcome, although most electricians prefer not to turn down a commutator unless absolutely unavoidable. A wavy commutator causes more trouble, and may need an alteration to the V-ring to overcome the trouble permanently. Some "Archbound" V-ring assemblies are subject to this fault and can be overcome by "nip-bending" the bars and segments.

(2) High bars usually become fixed in the new position and can be ground down. Trouble due to low bars is often difficult to eradicate owing to the spring of the grinding tool. Although after grinding the commutator shows a polished surface, the bars may still be slightly low, so that under load the fault will show up again. The remedy is to fix the grinder rigidly and feed it lightly across the face several times. The usual symptoms of an unseasoned commutator are that after turning true it runs well for a while, after which the sparking slowly increases, while the commutator becomes patchy in colour, due to the low bars burning away. This trouble may be remedied by heating the commutator to approximately 220°F., spinning the armature to approx. 10 per cent. overspeed, tightening the V-ring slightly and repeating the process. When turning the commutator after cooling down, rigid support for the turning tool is again necessary. Burnt bars can be filled but are better replaced and new mica fitted. An open circuit is often indicated by blackening of equally spaced points around a commutator.

(3) High mica should be well undercut, making sure to remove any edges of mica which might cause early trouble. Short circuits in the commutator itself usually arise from charred oil in the mica segments and these should be renewed. Softness of copper is a property of the metal and after a period of normal running invariably cures itself.

(4) A reputable brushmaker, who will require all possible data available, should be advised of trouble due to incorrect type of brush. Due regard should be given to his recommendation, whilst the angle of the brush to the surface, grinding in of the brush, its fit in the holder and the spacing of the brush arms and brush position all require attention. A brush pressure of 1½ lb. per sq. in. should be maintained.

(5) Sparking may be caused by unevenly spaced fields or poles of uneven strength due to distortion of the yoke, unequal air gaps, partly shorted or wrongly connected field coils and poor inter brush-arm connexions. Armature re-winding usually means replacing the winding with the original type and style, and rarely is anything gained by an alteration. Whenever possible the coils should be dried out, and varnished before inserting in position. Slots should be freed of old varnish and insulation, and sharp edges removed.

Helical Grooving.—A paper on the helical grooving of slip rings and commutators has been brought to our notice and, although it is not common practice, it has been used by the New South Wales Railway Department with excellent results. It is claimed that the grooving reduces operating temperatures and gives better overload capacity, reduced commutator maintenance and longer brush life. A test on a 1000 kW, 600 v. rotary converter, with grooving ⅛ in. wide, ⅜ in. pitch and $\frac{1}{16}$ in. deep gave the following results:—

	Before. Grooving	After. Grooving
Average load	2400 amps.	2533 amps.
Temp. rise	33°C.	20°C.
Rate of wear per inch..	7000 hrs.	12600 hrs.

Some of the sugar mills with fairly large D.C. machines may have already tried grooving; we feel sure that some very interesting results could be obtained with this method of improving commutation.

Juice Level Control in Evaporators.[1]

By J. L. CLAYTON.

A common source of inefficiency in operating evaporators is the static head of the juice within each cell. Whenever the rate of supply of clarified juice increases temporarily, there is a strong temptation to raise the levels throughout the system in an endeavour to utilize the effets as temporary storage space. As a result of this practice, the overall rate of evaporation may be seriously reduced, so that the difficulties are accentuated rather than relieved. Authorities agree that the optimum working level is at one-third of the height of the calandria, though this may vary slightly with local conditions, and is, in any case, not critical.

Before any attempt may be made to operate the effets in such a desirable fashion, some means must be provided for indicating at any time the actual static level of liquid in a vessel. Owing to the violent ebullition which forces the vapour-liquid mixture at high velocity through the tubes, any attempt to form an opinion of even the approximate static level by observation through the sight glasses is practically futile. This level can, however, be accurately indicated by a simple gauge, and many effets are already provided with such accessories, which consist merely of a vertical glass tube set level with the calandria, and connected at top and bottom to the evaporator body. The provision of one of these simple devices on each vessel is obviously the first step towards efficient evaporator operation.

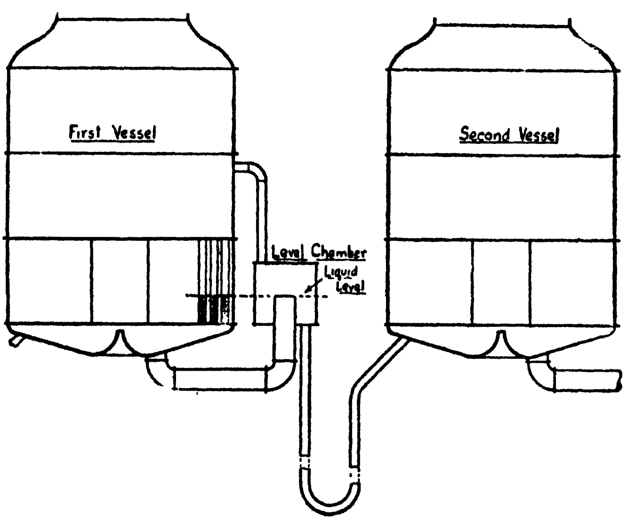


Fig. 1.

Even with proper level indication, the maintenance of the levels at a constant value by manual control is both tedious and exacting. Fortunately, the control may be made automatic without the introduction of complicated or expensive apparatus. The most common control method consists in regulating the quantity of liquid leaving each vessel, according to the level in that vessel. This may be accomplished by mechanical means, with the aid of a float, or by hydraulic means, for which an overflow weir is employed.

The Overflow Type Regulator.

In the overflow regulator (Fig. 1), also known as the Webre type, a weir box, vented to the cell at points above and below the liquid level, is attached to the side of the cell, set at such a height that the weir is at the optimum working level. A pipe, in the form of a U-tube, passes from the bottom of the weir box to the succeeding vessel. In operation, liquid which flows over the weir enters the pipe feeding the succeeding effet, and is drawn over through the U-tube by the pressure difference existing between the effets. The U-tube is necessary to provide a liquid seal between the two vessels which the tube connects. It follows immediately that the depth of the U-tube must be such that the hydrostatic head of liquid in the low pressure arm exceeds the difference in pressure between the two vessels.

This limits the minimum length of the low pressure arm, and a value some 25 per cent. greater than this is advised for practical installations. For quadruple effets, a low pressure arm of 18 ft. appears satisfactory. Normally, there should be no practical barriers to the installation of these U-tubes, but in special cases it may be necessary in order to accommodate them to introduce the feed near the top of the effet, thence through a funnel and pipe to the distribution area below the calandria.

Two obvious objections are : (1) The flash of the feed entering near the top of the cell may cause some entrainment. (2) The liquid would be difficult to collect, owing to dispersal by boiling and splashing. In some installations the height of the overflow weir is made adjustable, but with proper selection of pipe sizes, this would appear to be an unnecessary complication, save in the original determination of the optimum working level.

Judged simply as a juice level regulator, the overflow type is undoubtedly the cheapest and simplest available. It has no moving parts, and once installed is entirely self-regulating. It is, however, suitable for outward-flow control, wherein the level of liquid in each vessel is maintained constant by controlling the

[1] *Proc. Queensland Sugar Cane Tech.*, *12th Conf.*, pp. 25-34 (here abridged).

rate of flow of the liquid *leaving* that vessel. This has certain drawbacks which will be discussed later.

Float-operated Regulators.

Float-operated regulators all embody a valve coupled mechanically or hydraulically to a float which rises and falls with the level of the liquid in the effet vessel. It is customary to mount the float in an external chamber, connected as in the previous case, but with the exception that the chamber now serves

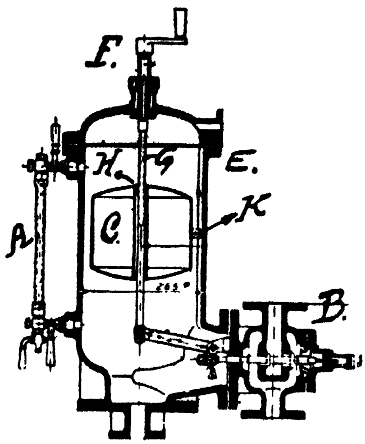


Fig. 2.

solely as a float housing, and is not associated with the pipe through which liquid passes to the next vessel.

Fig. 2 illustrates one of the many possible applications of this system. The float chamber is connected to the effet vessel by the small flanges at top and bottom; the float *C*, which varies in height with the level of liquid in the effet is mechanically linked to the valve *B* which controls the flow of liquid either to or from the effet in question. Gauge glass *A* provides for visual observation of the working level, and handle *F* may be used to vary the level at any time, even during operation.

There is no limit to the number of ways of constructing a mechanically operated float control system, yet most of these have two obvious defects: (1) The float must be connected to a mechanism external to the low pressure vessel. This calls for the use of a stuffing box, which, in addition to providing a source of air leakage, impedes the free movement of the float, and thus introduces a lag into the control characteristics. (2) Further lag is introduced by the fact that the force required to actuate the valve and the link motion must be supplied by the float.

It should be noted that the float mechanism illustrated in Fig. 2 does not suffer greatly from the first of these defects, since the float chamber is not connected, even indirectly, to atmosphere. The only source of leakage is between two liquid systems, at pressures which would not differ greatly.

In an attempt to overcome the second defect, due to the inertia of the valve and linkage, hydraulic control systems have been applied, the actuating fluid being either air or steam. In such cases, the float is required to actuate only the light moving portion of a pilot valve which in turn controls the action of the hydraulic fluid upon the main valve. Thus the float control is made appreciably more sensitive, but at the added expense of hydraulically operated equipment. An air-operated system of this type is in operation at the Pioneer Mill Co., Hawaii.[1]

Electrical Control System.

So far as the author is aware, no attempt has been made to control the level within the effet by electrical means. This should, however, be simple to accomplish in practice, without the use of a float or any moving parts save a motor-operated valve in the liquid line. As shown in Fig. 3, within the simple external chamber are located two electrodes, spaced equally above and below the desired level.

By means of the circuit depicted, the control motor may be brought into action as soon as the liquid level in the vessel passes out of the dead range between the two electrodes. The direction of rotation of the motor would, of course, be designed to restore the level to a point within the dead range. This system should obviate the defects associated with float control, and costs would almost certainly be less than for hydraulically operated equipment.

It has been stated that the simple U-tube type of level control is suitable only for outward-flow control.

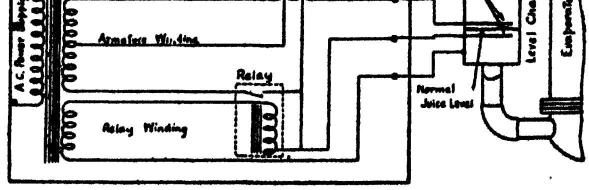


Fig. 3.

On the other hand, the float-operated and electrically-operated types are suitable for outward- or inward-flow control. For simplicity, these will be designated "forward" and "backward" control respectively, on the assumption that the flow of the feed from one vessel to the next is regarded as forward flow.

[1] *I.S.J.*, 1940, p. 172.

Forward control, as depicted in Fig. 4, using the connexions marked *a*, is the more common. Yet despite the frequent adoption of this system, a big defect is at once apparent. Consider an effet installation working under steady conditions, and suppose that an extra quantity of juice enters the first vessel. If no extra steam be admitted to the first vessel, the evaporation remains appreciably constant.

The raised level in the first vessel causes increased flow of the second vessel, and so on, so that the change in the flow of juice to the set is reflected promptly in the higher quantity and lower density of the syrup produced. Therefore, in the absence of a flow meter on the feed line to the first vessel, the first indication of a change in the clarified juice supply is a rise or fall in the density of the syrup, and the evaporator station hand must adjust the steam supply according to the variations in the latter value. Thus, the forward control system, whilst capable of maintaining practically constant levels throughout, does little to compensate for changes in the feed.

be necessary to increase the rate of withdrawal of syrup—with consequent reduction in density.

It is difficult to understand why the backward control system has not received some publicity, since it appears to lack nothing in comparison with forward control, and possesses the added advantage of *demanding* proper regulation of the evaporation rate, whilst tending always to produce syrup of a constant density. The ability of the forward control to continue to operate, albeit unsatisfactorily, without any attention to the steam supply, may hardly be considered an advantage, except possibly in the case where the evaporator station is under capacity and the evaporation rate is maintained at a maximum almost continuously.

COMPLETELY AUTOMATIC CONTROL.

Level regulating devices, being responsive only to changes in the quantity of the liquid supplied to the effets, cannot take account of changes in concentration (Brix of clarified juice) resulting from different qualities of cane treated or alterations in the degree

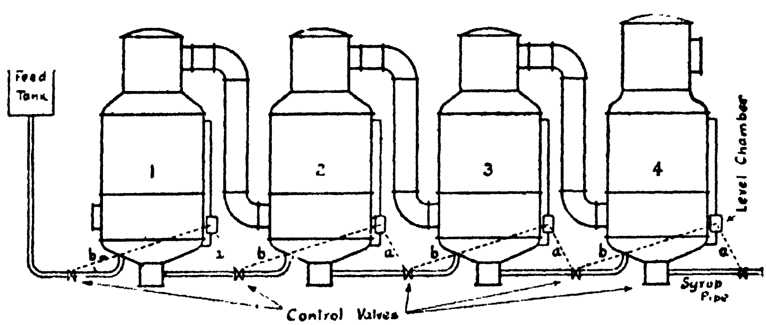


Fig. 4.

Consider, on the other hand, the backward control as depicted in Fig. 4, using the connexions which are marked *b*. In this case, the controlling factor is the rate of removal of syrup, and so long as this is constant, the rate of feed is controlled entirely by the levelling devices. It follows at once that any excess of clarified juice over the normal supply will be unable to enter the evaporators, and must be accommodated in a feed storage tank. This excess feed may be introduced into the effets by increasing the steam supply.

Thus, the practical operation of such a station would consist of manipulating the steam valve so as to ensure that the feed storage tank neither emptied nor overflowed. There would appear to be no objection to controlling the steam supply automatically by means of a float in the feed supply tank, the mechanism being so adjusted that with the tank empty, the steam valve would be closed, and with the tank nearly full, the steam valve would be fully open. In the event of the evaporators being unable to cope with the full supply of clarified juice, it would

of dilution at the milling station. Systems have been devised whereby the complete control of the evaporator station may be made automatic, and a brief note on the features of such equipment may be of interest.

At the outset it must be made quite clear that the whole aim of automatic evaporator control is to produce a syrup of constant Brix. It follows then that the system is applicable only to effet sets which have sufficient capacity to handle comfortably the highest feed supply of which the mill is even temporarily capable.

With automatic control, the feed liquid does not represent the sole variable factor, and it becomes necessary to ensure that neither the steam pressure nor the vacuum in the last vessel is capable of varying of its own accord. This calls for expensive equipment apart altogether from the evaporator control gear.

Control systems in operation in Hawaii[1] employ automatic float regulation of levels, in the forward

[1] *Loc. cit.*

direction. A Micromax (boiling point difference) recorder on the last vessel is used to actuate the valve through which passes the steam to the first vessel. Due to the excessive time lag of the system, a delay switch is incorporated, so adjusted that following a change in the steam supply, no further change may be made until the effet has become apparent at the Micromax controller.

Much complicated equipment is associated with the automatic starting up and closing down of the station, and it would appear that automatic evaporator control will dispense partly with the services of one man per shift, at the cost of a considerable capital outlay and the services of a skilled technician to adjust and maintain the equipment. In the absence of practical experience, one can only say that the proposition does not appear attractive, particularly in view of the fact that the superiority of automatic control over manual control is probably of minor importance.

Effect of Certain Subsider Fittings

On the Rate of Juice Settling. II.

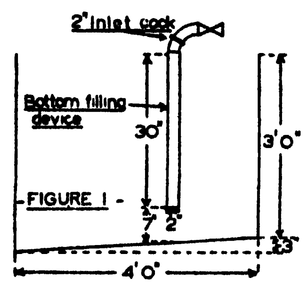
By J. G. DAVIES and R. D. E. YEARWOOD,
Imperial College of Tropical Agriculture, Trinidad, B.W.I.

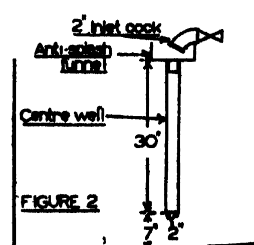
In a previous article,[1] the results of some experiments carried out during the 1940 crop were reported. The main conclusions were : (i) that the fitting of a centre well to an intermittent subsider, whether uncovered or covered, resulted in a definite increase in the rate of settling ; (ii) the use of a bottom filling device did not give such good results as a centre well ; and (iii) covering an ordinary subsider seemed to retard the rate of settling.

Several centre well installations have been made as a result of the experiments. Most of the installations are based on the centre well diameters stated which are calculated to give a ratio of juice velocities between discharge from inlet pipe and discharge from centre well of 25 : 1. The actual velocity (in f.p.m.) at discharge from centre well therefore depends entirely on the velocity of discharge from the inlet pipe.

Since it was thought that the velocity of discharge from the centre well might effect the rate of settling, further experiments were undertaken during the 1941 crop. Other possibilities requiring factory trial were also examined. These 1941 experiments carried out in the College experimental factory are divided into three sections.

(i) 2 *in. Centre Well vs.* 2 *in. Bottom Filling.*—The object of this series was to determine whether under comparable conditions, the release of residual flash vapour, air, etc., had any effect on the rate of settling. In the College factory the juice is delivered from the juice-heaters to a flash tank and runs by gravity to the subsiders. In spite of this, there is always a certain amount of additional vapour and gases released from the juice as it discharges to the subsiders. In using a bottom filling device, of this or any other type, it was thought that turbulence might therefore be created for this reason. The 2 in. bottom filling device used was the same arrangement as that employed in the 1940 experiment (Fig. 1). The 2 in. centre well was similar in every respect to the bottom filling device except that it was open to the atmosphere at the upper end (Fig. 2).



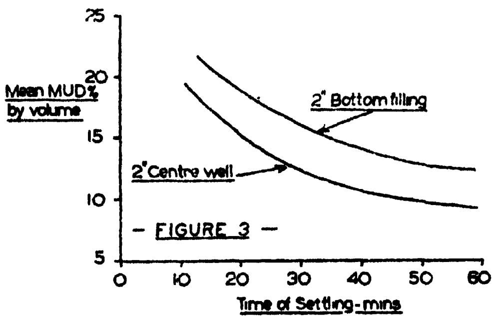


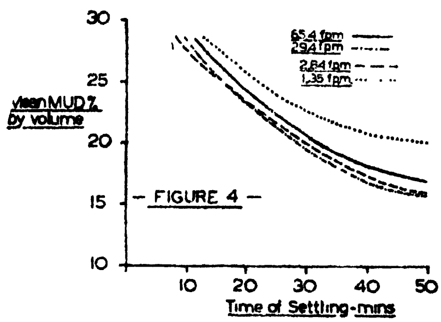
(ii) *Centre Wells giving Different Juice Inlet Velocities.*—The 10 in. centre well used in the 1940 series gives a juice inlet velocity of 2·64 f.p.m. In this present series this velocity was tested against others of 65·4 f.p.m. (2 in. centre well), 29·4 f.p.m. (3 in.

[1] *I.S.J.*, 1940, pp. 245-248.

centre well), and 1·35 f.p.m. (14 in. centre well). The centre well arrangement in each case was similar to that shown in Fig. 2.

(iii) *With Oil Seal vs. Without Oil Seal* (14 *in. Centre Wells*).—This series was carried out as a result of a suggestion received from Mr. D. M. SEMPLE of the Mirrlees Watson Co., Ltd. The use of an oil seal on





an intermittently operated subsider is not, as will be shown later, a practical proposition, but the results obtained are of interest when considered in conjunction with the uncovered *vs.* covered series of experiments of 1940.

FACTORY RESULTS AND DISCUSSION.

(i) 2 *in. Centre Well vs.* 2 in. *Bottom Filling*.—The mean rate of settling curves of quadruplicate tests are shown in Fig. 3. There appears to be little doubt that the centre well increases the rate of settling in comparison with the bottom filling device. Although the juice had passed through a flash box, the release of all residual vapour, air and other gas from the incoming juice, prior to its discharge into the main body of the subsider, is therefore beneficial. A comparison of clarified juice turbidities and mud densities is set out below :—

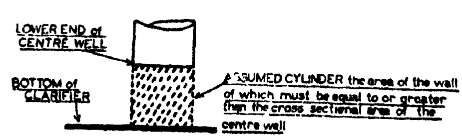
	2 in. Centre Well.		2 in. Bottom Filling.
Clarified juice, C.S.R. turbidity ..	0·07	..	0·10
Mud, total insoluble matter, per cent.	3·65	..	3·22

The difference in clarified juice turbidity is probably not significant, but the results are concordant with the mud analysis, which tends to favour the centre well.

(ii) *Centre Wells giving different Juice Velocities.*—The mean rate-of-settling curves for quadruplicate tests are shown in Fig. 4. It will be seen that there is a slight increase in the rate-of-settling when juice inlet velocity is decreased from 64·5 f.p.m. to 29·4 f.p.m. On further decrease of velocity to 2·64 f.p.m., and finally to 1·35 f.p.m., the rate of settling decreases. It will be remembered that the work of 1940 was based on a juice inlet velocity of 2·63 f.p.m.

With both the 2·64 f.p.m. (10 in. centre well) and 1·35 f.p.m. (14 in.) juice inlet velocities the size of the subsiders and the locations of the juice inlet pipe and the float draw off arrangement were such that there was little clearance, 1 in. or less, between the centre well and one of the sides of the subsider. Ample clearance was available with the centre wells giving 29·4 f.p.m. (3 in.) and 65·4 f.p.m. (2 in.), by which is meant that no eddying whirls were created in the main body of the tank by the incoming juice due to lack of room. When the juice is admitted at 2·64 f.p.m. (10 in.) such whirls do exist but to no great extent. They are definitely much less than with ordinary filling. At 1·35 f.p.m. (14 in.) a very appreciable whirl is set up, especially through the small channel between the outside of the well and one side of the subsider.

In the light of these observations, the reason for the poorer performance at 2·64 f.p.m. in comparison with 65·4 f.p.m. and 29·4 f.p.m. and the even poorer performance at the lowest velocity of 1·35 f.p.m. is easy to understand. The trend of the curves for the two higher velocities, 65·4 f.p.m. and 29·4 f.p.m. would appear to indicate that the juice velocity at discharge from the centre wells on the intermittently operated subsiders may be of importance. Further, it is also evident that the centre well must so be placed that there is no possibility of velocity increases in the main part of the subsider, as for example between the centre well and the side of the tank.



— FIGURE 5 —

In considering velocity increases, a further factor is of obvious practical importance. Juice discharge velocity from the centre well is calculated from the volume of juice flowing per unit of time and from the cross sectional area of the centre well. While the open lower end of the centre well is undoubtedly the point at which the incoming juice is discharged into the main body of the tank, it is also self-evident that

the area of the wall of an assumed cylinder formed by projecting the centre well pipe to the bottom of the tank is equally important. This is illustrated by Fig. 5. Each of the centre well pipes used was 7 in. off the bottom of the subsider. The area of the walls of the assumed cylinders in comparison with the cross sectional area of the centre wells is shown below.

Centre Well. Diam.	Area.	Assumed Cylinder. Height.	Assumed Cylinder. Wall area.
2 in.	3·14	7 in.	43·96
3 in.	7·07	7 in.	65·94
10 in.	78·54	7 in.	219·87
14 in.	153·00	7 in.	307·86

It is therefore apparent that in none of the four cases was there a subsequent increase in velocity of the juice after discharge from the centre well proper.

Also, it is worthy of note that mathematically the area of the wall of the assumed cylinder is equal to the cross sectional area of the centre well when the height of the assumed cylinder is one-fourth the diameter of the centre well. But in order to provide adequate space for juice to flow, two other functions must be taken into account. They are : (i) the change in direction of the juice flow and the desirability for a further reduction in juice velocity to help throw off the mud particles; (ii) the tendency for mud to accumulate in this area thereby reducing the effective height of the assumed cylinder.

In view of these considerations, it is thought that the height of the assumed cylinder should be at least one-half the diameter of the centre well. Below are set out the clarified juice turbidities and total insoluble matter per cent. mud.

Velocity of juice ex. centre well, f.p.m.	65·40	29·40	2·64	1·35
Clarified juice, C.S.R. turbidity	0·12	0·16	0·11	0·19
Mud, total insoluble matter, per cent...	2·38	2·43	2·67	2·01

It would appear doubtful whether the differences are significant. Except for the lowest velocity, total insoluble matter per cent. mud corrected to mud volume at 50 mins. appears to increase with decreasing juice inlet velocity. This points to the lower velocities giving denser muds, which would be expected. It is doubtful, however, whether any conclusive information can be gathered on this aspect of the problem with the present equipment at the experimental factory because of sheer lack of necessary space in the subsiders, as previously mentioned.

(iii) *With vs. Without Oil Seal (Inlet Velocity 1·35 f.p.m. 14 in. Centre Well).*—The juice inlet velocity of 1·35 f.p.m. was used because, as is shown in the previous section, there is perforce a certain amount of turbulence under the experimental conditions. The use of an oil seal for intermittent operation is not altogether convenient. Its use, however, is patented in conjunction with the Bach Continuous Subsider, hence operating objections are removed in that connexion. The results of these experiments on the intermittent operation, with and without oil seal, are presented below :—

	With oil seal.	Without oil seal.
Juice inlet velocity, f.p.m.	1·35	1·35
Time of settling, mins.	45	45
Per cent. mud by vol. after decantation	7·50	16·50
Temperature of juice prior to decantation (one reading)	90°	86°

The increased benefit obtained when adequate surface insulation is provided is immediately apparent. Where flocs are allowed to rise to the surface during the filling of the subsider, further small currents are set up by inadequate heat insulation at the surface which retard the settling of such flocs very considerably. But when adequate heat insulation is provided by an oil seal, surface currents do not exist and the flocs settle rapidly in the normal way. Also there is increased heat economy as shown by the difference in temperature of the clarified juice.

Conclusions.

In drawing conclusions from this and the previous (1940) series of experiments, it would appear that the conditions for the proper design for a centre well fitted to an intermittently operated subsider are :—

(i) It should be open to the atmosphere at the top in order to release any residual flash and included gases.

(ii) It should be of such diameter as to give as low a velocity of juice discharge at the lower end as possible. This recommendation is tentative until further facilities can be found so that more definite information can be obtained.

(iii) The area of the wall of an assumed cylinder formed by projecting the centre well to the bottom of the subsider must be greater than the cross sectional area of the centre well. This ensures no subsequent increase in juice velocity after discharge from the centre well. It is suggested that the height of the assumed cylinder should be at least one-half the diameter of the centre well.

(iv) Top heat insulation appears beneficial when a centre well is fitted, but the use of an oil seal has certain objections for intermittent operation. It does however, result in increased heat economy.

Each of the above applies to rectangular shaped subsiders. No work has yet been carried out on the newer circular type, but there is no reason to suppose that the same principles should not hold good.

Acknowledgment is made of the help rendered in collecting the factory data by the following students : C. W. Fitzwilliam, E. A. Satirabal and P. D. Smith.

A Solar Water-heating System.[1]

By G. BATES.

Design and Construction.—An article written by Dr. H. W. Kerr,[2] inspired the writer to construct a domestic unit with the object of testing it under North Queensland conditions. The results have been gratifying, and the following particulars regarding its construction are furnished in the hope that others will be encouraged to adopt this simple and cheap method of heating supplies of water for domestic and other purposes. This particular installation could be improved, but on the whole is quite efficient.

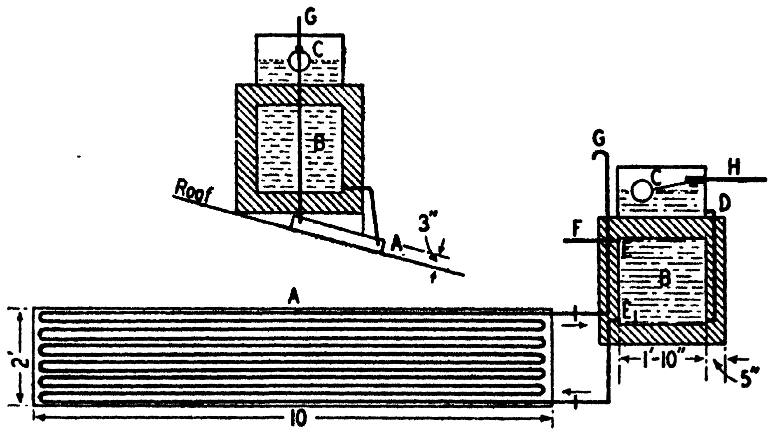


Fig. 1—Solar water heating system.

It will be seen that the unit (see Fig. 1) consists of two distinct parts, the *absorber* and the *storage tank*. The absorber is composed of a bank of pipes or a "flat" coil of ¾ in. iron water piping, set on a sheet of galvanized iron within a shallow box, and protected from the cooling action of wind by a glass cover. The coil contains 12 lengths of piping each 9 ft. 3 in. long, joined together by low pressure return bends. This length of pipe was selected mainly because it was obtained by cutting standard lengths of water-piping in halves, thus reducing the labour required to make the coil.

To increase heat absorption, the coil and galvanized iron were painted black after setting in the shallow box. The dimensions of the box are 10 ft. × 2 ft., giving a heat absorbing surface of 20 sq.ft. The upper part of the coil is connected directly to an insulated storage tank, while a feed pipe leads from the base of the storage tank to the lower portion of the coil; the base of the absorber is set somewhat lower than the bottom of the storage tank. The storage tank is made from plain galvanized iron and is insulated by a layer of sawdust of 5 in. minimum thickness.

The maximum amount of heat is absorbed when the rays of the sun strike the absorber at an angle of 90°, but, of course, this angle could not be maintained throughout the whole day unless the absorber were mounted on gimbals and mechanically rotated. In practice, it is found sufficient to expose the absorber on a sunny slope of the house-roof at an angle of some 15° from the horizontal.

The operation of the system can best be explained by reference to the figure. On exposure to the sun, water in the coil *A* becomes heated; it rises by convection and flows slowly upwards, eventually entering the storage tank at its highest point, *E*. The warm water thus removed from the coil is continuously replaced by cooler water from the base of the tank through the outlet E_1. There is thus a continuous circulation of water while the sun is shining, the temperature of the water in the storage tank gradually increasing throughout the period of sunlight.

The household requirements are drawn from the topmost layer of water in the tank (this being the hottest zone) through the ½ in. pipe, *F*. The supply in the tank is then replenished from the base through the intake pipe, *D*, this flow being controlled by a ball valve operating in an overhead six-gallon supply tank, *C*, connected with the service supply pipe, *H*. In order to minimize losses by radiation, and maintain supplies of hot water overnight, good insulation of the storage tank is an obvious essential.

It has been determined in the U.S.A. that a minimum average of six hours sunlight per day is necessary for the successful operation of a solar heater; under such conditions, 1 sq. ft. of heating surace (i.e., the coil and the metal to which it is clamped) will heat one gallon of water per day to approximately 150°F. (66°C.), the temperature rising with increasing hours of sunlight.

The storage tank should be of ample capacity. In a domestic installation it is a good rule to allow a daily average of about 15 galls. per member of the household, although this quantity can be reduced in warmer climates. In the installation under consideration the capacity of the storage tank is slightly less than 40 galls., while the area of the absorber is only 20 sq.ft., or half the generally recommended ratio. Against

[1] *Proc. Queensland Soc. Sugar Cane Tech., 12th Conf.*, pp. 207-214

[2] *Canegrowers' Quarterly Bulletin*, April, 1926.

this, however, is the fact that the intake temperature of the water is comparatively high.

Operation.—Although the system is functioning satisfactorily, it was deemed desirable to obtain actual measurements of performance. The storage tank was accordingly emptied and refilled with cold water, the temperature of which was found to be 95°F., the average shade temperature during the day being 94·6°F.

On noting the temperature of each gallon of water delivered, it was seen that the maximum increase was 31°F., and that the average temperature of the first 20 galls. was approximately 121·5°F., or an increase of 26·5°F. In practice, however, owing to the capacity of the storage tank being considerably greater than that actually required, there was a considerable carry-over of heated water from day to day, and a supply with a temperature in excess of 135°F. was commonly obtained. The drop in temperature between 7 p.m. and 7 a.m. has ranged from 8 to 15°F., thus indicating that the insulation or elimination of reverse circulation is not satisfactory.

Discussion.—These temperatures fall short of what should be obtained with a daily minimum of six hours sunlight, but, by some attention to the following points, the efficiency of the unit could be greatly improved.

(1) Lightly insulated copper piping should be used to eliminate much of the heat loss in transmission; moreover, the storage tank should be placed much nearer the point where water is most frequently drawn. (2) Both the storage tank and the absorber rest on the roof, and, after 3 p.m., the tank, being at the western end, begins to shade the absorber. The best position for the storage tank is above the house ceiling, under cover of the roof. (3) The insulation of the absorber box is quite inadequate.

With the provision of the recommended proportion of absorber surface (i.e., 1 sq. ft. per gall. of tank storage), and the elimination of the above-mentioned defects, it would be very easy to get a daily supply of 40 galls. of hot water at a temperature in excess of 150°F.

The solar heater has been extensively developed in the United States, and particularly in California, where the ratio of cloud is low, and temperatures are mild in winter. It is used for heating water for hotels, apartment houses, industrial processes, for use in dairies, and for domestic purposes; in Hawaii, the system is widely used on the sugar cane plantations. Such installations naturally require the operation of very efficient units.

W. M. Farral,[1] of the University of California contrasting black *vs.* white absorbers found that, over a given period of exposure to sunlight, the standard black painted absorber raised the temperature of the water some 16°F. more than did the white painted absorber.

In order to increase the heating surface of the absorber beyond that of the surface area of the actual pipes, it is advised to clamp the coil to a metal plate (both being painted black), but better contact (and hence better heat conduction) between the pipes and the remainder of the absorbent surfaces is obtained by the affixing of metal fins to the pipes. A less expensive but quite efficient practice is to embed the coil partially in a thin layer of concrete, which forms a very efficient absorbing and conducting medium.

The Late A. J. Watts.

One of our very oldest subscribers has recently passed away in the person of Alfred John Watts. Well-known as a supervising sugar factory chemist in Brazil, he was born in Hampstead in 1859, being the son of Henry Watts, editor of the famous "Dictionary of Chemistry." He studied at University College, London, and for about two years worked in beet sugar factories in Russia. His first experience with cane sugar production was gained in Trinidad, after which he went to Pernambuco, where before long he acquired an important practice as consultant on agricultural and manufacturing problems. From time to time Watts contributed short notes to this *Journal*, as on "Diffusion of Shredded Cane"[2]; "Derivation of the word Muscovado"[3]; "Origin of the Uba Cane"[4]; "Restricting the Milling Operation"[5]; "Clarification for Polarization"[6]; and "Alcohol in Brazil."[7] With his death at a ripe old age, the sugar world loses yet another link with the more distant past.

Molasses Production in Cuba.—According to Mendoza of Havana, the production of molasses in Cuba during the 1940-41 season will amount to approximately 315 million gallons of high-test molasses, against 170 million last year. Included in this amount is some 23 million gallons made by melting down 100,000 tons of sugar.

U.S.A. Wholesale Price Increases.—Congress has just lately been devising legislation designed to fix a ceiling on farm commodity prices with a view to checking inflation. It is possible that cane and beet sugar may be affected at the farmer's end. For the basic line it is intended to take the average price for farm commodities ruling during the period between August, 1909, and July, 1914. But it has been pointed out by a witness before a Congress committee that as between August, 1939, and June, 1941, the wholesale price of sugar has only increased by 13·7 per cent., whereas other commodities have risen much more. Thus butter is up by 50 per cent., canned salmon by 48·9, dried beans by 64·5, coffee by 52 and lard by 68 per cent. Evidently sugar has lagged behind and might well claim some adjustment before the ceiling is fixed.

[1] *Bulletin* No. 469, June, 1929 [2] *I.S.J.*, 1920, p. 344. [3] 1923, p. 432. [4] 1924, p. 478. [5] 1930, p. 376. [6] 1933, p. 268. [7] 1935, p. 484.

Agricultural Abstracts.

The Mosaic Disease and Co 281. C. W. Edgerton. *Sugar Bull.*, **19** (1941), p. 28.

Co 281 is a valuable cane owing to its capacity to keep for a long time when windrowed. It has, however, after the first few years subsequent to its release, proved very susceptible to mosaic and there is no new variety ready or within sight with its particular qualities. It is, therefore, most desirable to attempt to control the disease for which rogueing appears impracticable. The disease spreads very rapidly, more rapidly than in other varieties but, by planting disease-free seed cane, a considerable degree of control is possible. Such seed cane, in 1940, gave a 15·7 per cent. infection whereas infected seed gave an infection of 100 per cent. The way lies in this direction and it is suggested that the American Sugar Cane League should father the work.

Some Effects of Cane Quality produced by Different Soils. R. J. Borden and L. R. Smith. *Hawaiian Planters' Record*, **44** (1940), p. 187.

Following preliminary trials, the present study is concerned with a series of pot cultures in 12 different soils but under conditions otherwise identical. The cultures were replicated for the two varieties D 1135 and 31-1389. Certain observable differences were found in the extent to which D 1135 tasselled and in the amount of "leaf freckle" developed on 31-1389. This latter appeared to be in inverse ratio to the amount of CaO in the soil. The comparisons are carried to the analytical differences found. The evidence is by no means conclusive but nitrogen has in some way been responsible, though the available nitrogen at time of planting seems to have little influence on the juice at harvest. The problem is, obviously, very complex but it is suggested that the key lies in the kinds, numbers and activity of the soil micro-organisms, of which no study was made. It may be suggested in this connexion that the extent of the development of mycorrhiza would be worthy of investigation.

Observations on Insect Pests in Samoa which are not yet known to occur in Hawaii. O. H. Swezey. *Hawaiian Planters' Record*, **45** (1941), p. 25.

Following the general policy adopted in Hawaii for the prevention of the introduction of potential pests from other parts of the world, Samoa has been explored and the results are here set forth. As in Guam, sugar cane is not extensively grown. The larger red variety is used for chewing, and the tops and the thinner varieties for thatching. Four pests are noted on cane: *Perkinsellia vitiensis*, in Fiji supposed to transmit Fiji disease; *Neomaskellia bergii*; *Cosmopteryx dulcivora*, the midrib leaf-miner; and *Melanitis leda solandra*, a butterfly widely distributed in China, Malaya and the Pacific Islands. The pests of other crops are also noted.

A Spectrographic Study of the Distribution of Mineral Elements in Sugar Cane. S. S. Ballard. *Hawaiian Planters' Record*, **11** (1940), p. 183.

This briefly noted study is primarily concerned with the determination of the minor and incidental elements in sugar cane tissues and their distribution in the plant tissues, leaf (green and dry) and stem (non-millable top, green-leaf and dry-leaf stem). Dry-leaf cane contains the highest concentrations of manganese, strontium and barium. Iron is equally abundant in all parts of the stem and lowest in the dry leaf.

The Cane Variety Situation. W. G. Taggart. *Sugar Bull.*, **19** (1941), p. 11.

The article is directed partly to allay the apprehension, caused by the comparative failure of the 1940 crop, that the sugar industry is about to face another period of cane failure, and partly to stimulate the cane farmers to take necessary precautions. It reviews the series of introductions of new varieties, POJ 234 in 1926, POJ 213, POJ 36 and POJ 36M shortly after, CP 807 and Co 281 in 1930, Co 290 in 1933, CP 28/11 and CP 28/19 in 1934, CP 29/320 in 1935, CP 29/116 in 1936, CP 29/103 and CP 29/120 in 1939. Behind these are eight or ten varieties capable of being released and breeding work is still continuing. The variety situation, thus, appears well in hand. What is not so satisfactory is the control exercised by the farmer by such measures as selection of healthy planting cane against mosaic. A warning, too, is conveyed against the practice, stimulated by the feeling of uneasiness, of introducing canes otherwise than through the quarantine stations.

Windrowing and Storing of Sugar Cane in Louisiana following Injury by Freezing Temperatures. J. I. Lauritzen, C. A. Fort and R. T. Balch. *U.S. Dept. Agric., Tech. Bull.* 736 (1940).

The Louisiana cane farmer is on the horns of a dilemma. If he windrows early to avoid frost, he runs the risk of loss of sucrose through inversion; if he delays, the cane may be injured by frost. Of seven commercial canes, Co 281 is most resistant to inversion and is followed by Co 290 and 29/116. Considerable inversion takes place in the remainder, CP 807, CP 28/11, CP 28/19 and CP 29/320. There is need for a criterion as to when, and when not to windrow cane injured by frost and the present paper deals with this question with respect to Co 281 and Co 290. The criteria chosen are freedom from excessive inversion, absence of abnormal changes in acidity and *pH* value and little gum formation.

Frost progressively attacks the spindle and leaf tips, the terminal eyes and stalk and finally the lower eyes. With regard to fermentative changes resulting in the loss of sugar, cane showing different degrees

of injury from frost behaved similarly under different temperatures and humidity in the windrow. The more important question, however, is gum formation for gum interferes, and may prevent clarification and the recovery of sugar. Gum formation appears to be related to acidity and is due to the invasion of the gum-forming organism, *Leuconostoc mesenteroides*, which attacks only dead tissue. The first development of acidity and gum formation takes place in the upper part where they reach their greatest intensity, and progressively decrease below. The behaviour of cane in which all the eyes are killed depends on a degree of injury for which no physical measurement has yet been determined. Such cane may be kept for weeks without souring or gum formation or these changes may rapidly supervene. The weather conditions subsequent to windrowing do not appear to be the effective cause. Once the critical point has been passed it is immaterial whether the cane is windrowed or left standing. A possible means of determining promptly whether the critical point has been reached is storage at a high temperature (say, 80°F.). The practical conclusion is that it is best to windrow cane before injury by frost has occurred but, where this is impossible and sound eyes are found, windrowing may be adopted. Both Co 281 and Co 290 will windrow from three to six weeks without serious increase in acidity, decrease in *pH* value or gum formation so long as any eyes remain sound.

A Survey of the Insect Pests of Cultivated Plants in Guam. O. H. Swezey. *Hawaiian Planters' Record*, **44** (1940), p. 151.

The fear of the introduction of pests and diseases through the contact established between Hawaii and Guam by means of the aeroplane was responsible for this survey. A detailed list of the various potential pests found is given for the major crops. Sugar cane is only grown to a small extent in Guam and the pests discovered are those generally distributed throughout the Pacific Islands. They include *Rhabdocnemis obscura*, the leaf-hopper *Perkinsellia thompsoni*, several mealy bugs, the aleurodid *Neomaskellia bergii* and the derbid leaf-hopper *Proutista moesta*. *Aphis sacchari* was not found.

Morphology of the Vegetative Organs of the Sugar Cane. E. Artschwager. *J. Agric. Research*, **60** (1940), p. 503.

The author of this paper is the successor to Barber, whose last paper appeared in 1919, and Jeswiet who completed his *Beschrijving der Sooerten van het Suikerriet*. in 1925. The present paper brings up-to-date the information available on the morphology of the vegetative organs of the sugar cane, dealing in detail with the successive organs in some 45 pages. Perhaps the most interesting part of the paper is that in which the stability of the various characters is discussed. This has an important bearing on varietal determination for, the more stable a variety is, the more valuable it becomes for this purpose. The range of variation in the characters of the various organs is discussed in this section on the basis that they are the expression of inherited tendencies modified by environment. The characters that vary little are those usually associated with organs of ancient origin.

Results of Experiments with Chlorotic Streak. A. V. Abbott. *Sugar Bull.*, **19** (1941), p. 60.

Previous work having shown that chlorotic streak was capable of giving rise to large losses, further investigations were made in 1940 and the results are here given. These show for CP 28/19 and CP 29/320 respectively, germination losses of 4·3 and 31·0 per cent., reduction of yield cane 1 and 16 per cent. and reduction in yield of sugar 9·0 and 26·3 per cent. The relatively less loss in yield over germination is due to the fact that many diseased stools eventually sucker. It is these that lead to the observed reduction of 1·1 points in the sucrose content of the crop from disease-free cane. Secondary spread appears to be largely a question of locality. Varietal resistance tests, limited to plant canes, gave no very reliable information. In these a single stool of Co 290 was found infected, the first record from Louisiana. Rogueing appears to be more readily effected than in the case of mosaic if carried out in fields with less than 5 per cent. initial infection. In the present state of knowledge of varietal resistance, rogueing and seed selection, with hot water treatment of the seed, seem to be the most promising control methods.

A Survey of the Yields of Sugar Cane in Jamaica, 1937-38. H. H. Croucher. *Dept. Sci. and Agric., Jamaica, Bull.* 24 (1940). The Same, 1938-39. R. F. Innes. *Dept. Sci. and Agric., Jamaica, Bull.* 23 (1940).

These surveys are respectively the fifth and sixth to be made and give details of variety, area and yield in the different ecological areas into which the island is divided.[1] The yields and production for the whole island in the first of these years constitute a record due, primarily, to increased acreage. BH 10/12 retains its outstanding supremacy and judging by the area planted to it (43·67 per cent. of the plant cane area in 1938-39), is increasing in popularity, attributed to the greater care exercised in the control over mosaic. POJ 2878 comes second at 20 per cent. of the total area and is succeeded by mixed canes which still stand at the high figure of 17·43 per cent. Of the remaining canes, POJ 2727 alone is growing in popularity with 9·96 per cent. of the total area. Both the area and average yield show a falling off in the last year. The marked improvement in yield on high yielding estates in the earlier year was not maintained. While all the estates are included in the returns, only 16 per cent. of farmers' cane, which forms 25 per cent. of the whole, is included.

[1] *I.S.J.*, 1937, p. 256.

Chemical Reports and Laboratory Methods.

Operations of the Experimental Sugar Factory, Imperial College of Tropical Agriculture, Trinidad, Crop 1941. J. G. DAVIES. Contributed to this Journal.

Grinding started at 6-0 a.m. on Tuesday, March 4th, 1941, and finished at 3-0 p.m. on Thursday, April 3rd, 1941, liquidation, curing and bagging being completed by the following Saturday evening. A total of 663 tons of cane, B 3013, B 3127, BN 10/12, were ground. As regards cane quality, the Brix of the first expressed juice was slightly higher than last year,[1] mixed juice purity appreciably lower and reducing sugar ratio appreciably higher. Fibre per cent. cane was lower than last year.

	1941.		1940.
Absolute juice expd. per cent. cane	77·44	..	76·23
Pol. in juice per cent.pol. in cane ..	89·96	..	89·50
Absolute juice lost per cent. fibre ..	62·08	..	61·86
Pol. per cent. cane	13·31	..	13·54
Pol. per cent. bagasse	4·29	..	4·39
Fibre per cent. cane	13·92	..	14·51
Maceration per cent. fibre	126·90	..	132·06
Tons fibre per hour	0·434	..	0·449

Pol. per cent. cane was 0·23 lower than last year, and fibre per cent. cane, 0·59 lower. Although the tons fibre ground per hour were less, tons cane per hour was 3·115 as against 3·009. A slightly lower amount of added water per unit of fibre resulted in the expected slight increase in absolute juice lost per cent. fibre.

The top rollers of the crusher and the three mills are spring-loaded, and therefore the actual pressure exerted is difficult to estimate. The values given by the makers at their recommended settings vary from 19·4 to 30·0 tons total load. With the mill engine operating at 90 r.p.m., the peripheral speeds vary from 17·2 to 20·7 f.p.m. Comparative boiling house figures for this crop and 1940 when the control was on the basis of absolute juice instead of normal juice are :—

	1941.		1940.
Abs. juice : Brix	18·53	..	18·60
: Purity	83·43	..	85·48
B.H.R.	82·42	..	87·12
Final molasses : Purity	44·66	..	42·40
Tons cane ground	663	..	637
Tons sugar made	62·449	..	65·169
Tons cane / ton sugar	10·61	..	9·78

Absolute juice purity was appreciably lower than in either of the two previous years. The boiling house recovery was also lower, chiefly due to research which resulted in the necessity for pumping *B*-molasses outside to avoid prolonged boiling off periods. This was reflected in the increase in the final molasses purity. The figure recorded is the weighted mean of all molasses pumped out, and it is therefore not indicative of the final molasses actually obtained from the Java massecuites. Undetermined losses were higher this year than in the last two years.

	1941.		1940.		1939.
Undetermined losses per cent. pol. in cane, ...	10·81	..	7·87	..	9·44

It has been pointed out in previous reports that these high values are due to the intermittent operation of the factory, i.e., daytime operation only, and to the losses brought about by instructional and research requirements.

The sugar output was in the form of yellow crystals and *B*-sugar, the tonnages being as follows : yellow crystals 33·79 ; *B*-sugar 28·66.

Manufacture of Acetic Acid and Acetone from Molasses. H. D. SEN.[2] *Proc. 9th Conv. Sugar Tech. Assoc. India*, **1**, pp. 327-346.

Acetic acid at the present time is produced largely by the dry distillation of wood, but it can also be made by a suitable fermentation process from molasses, firstly converting the sugars to alcohol using yeast, and secondly transforming the alcohol to acetic acid, using a suitable bacterial organism. Experiments on the technical manufacture of acetic acid by fermentation and of acetone (by the dry distillation of calcium acetate), using a small-scale plant have been conducted by the author, and the following is a summary of his conclusions :—

Bacterium aceti is the most suitable type of organism for the transformation of the alcohol contained in a fermented wash of 20°Brix into the acetic acid, the conversion efficiency being 88·8 per cent., and the time of acetification five days. Other stages in the manufacture are : distillation of the fermented wash, steam distillation of the residue, neutralization with soda or molasses ash, evaporation to dryness, liberation of the acetic acid with concentrated sulphuric acid, and finally distillation.

Working in this way, the yield of pure water-white B.P. acid is 331 lbs. per ton of molasses, out of the 560 lbs. which may be expected, that is a practical efficiency of 60 per cent. Its cost is estimated at 3·16 annas per lb. of pure acetic acid in a plant producing 1000 lbs. per day, the capital cost of which plant would be Rs. 35,200.

In regard to the acetone, which is obtained by the dry distillation of calcium acetate, 1 ton of molasses would give 436 lbs. of the calcium acetate, which in its turn would theoretically give 160 lbs. of acetone, the actual yield, however, being only one-third, or about 53 lbs. It is estimated that its cost would be about 7 annas per lb.

It is considered that some economy may be effected by working up the sodium and potassium sulphates into the corresponding hydroxides by the addition of

[1] *I.S.J.*, 1940, p. 358. [2] Biochemist, Imperial Institute of Sugar Technology, Cawnpore.

milk-of-lime for re-use in the process, thus eliminating the cost of the soda ash and reducing expenses appreciably. In all the calculations a return of 4 annas per maund of molasses to the sugar factories is assumed.

"It is established that glacial acetic acid, acetone and various salts of acetic acid may be manufactured economically by the fermentation process which can successfully compete with the wood distillation or synthetic process, the plant working smoothly once it is set up." Considerable quantities of acetic acid and its salts will be required as the dehydrating salts in the production of absolute alcohol and particularly for the manufacture of acetone, which can be obtained only through calcium acetate. (A photograph of an acetifier plant working at the Cawnpore Institute is given).

Aconitic Acid from Sugar Cane Products. M. A. McCalip and Arthur H. Seibert.[1] *Ind. & Eng. Chem.*, 1941, **33**, pp. 637-640.

Following the information given in their preliminary report,[2] the authors now present more complete data on the occurrence of aconitic acid from sugar-cane products. It is pointed out that Behr[3] found aconitic acid in molasses over 60 years ago, while Yoder[4] and Zerban[5] isolated it from Louisiana cane juice, the former describing it as the predominating organic acid present. Taylor[6] identified it in diseased and in healthy cane; and Prinsen Geerligs[7] detected it in a deposit from Cuban molasses. Then more recently Tanabe[8] showed that aconitic acid accounted for 90 per cent. of the total acid extracted with ether from POJ 2725 juice.

Identification.—To detect aconitic acid in sediment and scales, the authors procedure is to add four drops of glacial acetic acid to approximately 3 mgrms. of the washed, dry material, and heat gently over a light flame until one-half or more of the acetic acid has volatilized in order to free the aconitic acid; to then add 1 to 2 ml. of acetic anhydride and to again boil carefully with constant shaking for about 2 min. If aconitic acid is present, the mixture first turns pink, then magenta, and finally claret. A drop of pyridine added after the acetic anhydride makes heating at this stage unnecessary, and speeds up the colour changes.

Determination.—20 grms. of the sediment, which has been previously dried, are extracted with HCl, and the acid solution then extracted with ether for 24 hours, the residue left after evaporating off the ether being washed with benzene, dried at 70°C. under vacuum for 12 hours, and weighed. A weighed portion of this dry acid was titrated with standard alkali, and the total weight of pure acid thus calculated, using the neutralization equivalent of 58·55. In some types of scale, the ether extract may be highly contaminated with soluble inorganic salts, and it may then be necessary further to purify it by reprecipitating the calcium salt, which is again extracted with acid, and the acid solution extracted with ether. Based on the dry samples, here are some of the results obtained for the aconitic acid per cent. in sediment and scales :—

	1939 Samples.	1938 Samples.
Louisiana syrup sediment	56·21	57·44
Refinery pan scale	25·56	24·48
Evaporator scale	—	8·15

Occurrence.—Applying a similar method of working to that detailed above, the aconitic acid content of syrups from different cane varieties was determined, still using the neutralization equivalent of 58·55. Co 290, 0·85 to 1·33 ; Co 29/320, 0·90 to 1·01 per cent. This rather wide variation seems to be attributable to both the variety of cane and the locality in which it was grown. Two samples of final molasses were examined; one from juice clarified at 6·2 *pH* contained 2·52, while the other from juice clarified at 6·8 *pH* contained 1·80 per cent., both based on the solids.

Deterioration of Burnt Cane. Valeriano C. Calma. *Philippine Agriculturist*, 1941, **29**, pp. 660-669.

It is believed that burning does not cause deterioration to the cane provided that it is milled within 24 to 48 hours. Some centrals in the Philippines, anyway, penalize burnt cane as much as 4 to 5 per cent., because of the loss in sugar, and the trouble resulting in the clarification treatment of the juice. There appears to be doubt as to whether burnt cane should be topped and left standing, or topped and cut, and generally on the best treatment to be adopted.

In the author's studies two cane fields were used. In the first each of five plots was planted to the following non-flowering varieties : CAC 117, CAC 126, CAC 128 and POJ 2878 ; while in the second field only one cane was planted, a non-flowering variety, viz., PSA 14. Each of the varieties was divided into two lots, *A* in which the burnt cane was topped, cut and allowed to lie in the field, and *B* in which it was allowed to stand in the field without any treatment until harvested.

As a whole with the burnt flowering varieties, not much appreciable change occurred in the purity of the juice and in the yield of sugar per ton of cane during the first four days after burning, whether cut or whether left standing in the field. Five days after it had been burnt, however, a very marked decrease in the purity was noticed in all the four flowering varieties under treatment. These results corroborate

[1] Bureau of Agricultural Chemistry and Engineering, U.S. Department of Agriculture, Washington.
[2] *I.S.J.*, 1941, p. 217. [3] *Berichte*, 1877, 10, p. 351. [4] *I.S.J.*, 1911, p. 631. [5] *J. Ind. Eng. Chem.*, 1919, 11, p. 1034.
[6] *I.S.J.*, 1919, p. 521. [7] *I.S.J.*, 1934, p. 74. [8] *I.S.J.*, 1937, p. 401.

the findings of LOCSIN[1] who reported losses of about 26 per cent. in five days, and of CALMA,[2] who found a figure of about 32 per cent. after the same period.

Still dealing with the flowering varieties, once burnt there was no appreciable differences in the losses of sugar whether the cane had been cut, or whether it had been allowed to stand in the field. This was probably due to the fact that little or no inversion resulting from the metabolic processes, and especially from the development of buds, took place, the cells of the cane being ruptured and broken down by the heat of the fire.

Coming now to the non-flowering variety, PSA 14, during the first four days after it had been burnt, no appreciable difference in the yield of sugar per ton of cane occurred between the several treatments. Five days after, however, the cane left standing in the field showed greater loss of sugar than either the topped and cut, or the topped standing cane.

These results agree with the findings of HIND[3] and CALMA[4] who reported that deterioration of burnt cane was less rapid when the cane was cut than when it was left standing with the tops attached to the stalk. From the standpoint of the central and the grower, it would be an advantage to cut burnt non-flowering cane, as there would be less sugar loss than if it were allowed to stand in the field. (The results obtained in this paper were obtained under field conditions from about 70 tons of flowering and non-flowering varieties, i.e., sufficiently large to make the conclusions drawn from the studies fairly reliable).

A Cheap Covering for Vacuum Pans. W. W. SCHIPPERS. *Archief Suikerind. Nederl.-Indie*, 1940, **1**, p. 283. —Last inter-crop the Trangkil s.f. had before them the question of renewing the wooden covering of six vacuum pans, and the lowest estimates of Chinese contractors for so doing was *f*250 each "all in." However, after consideration it was decided to use bamboo mats in place of wood, the whole being covered with varnish to give it the usual brown colour. This simple covering was found to be both cheap and satisfactory. Total costs for the six pans, including labour, *f*167·4, or about 28 Dutch florins for each pan.

Levulose from Ti Root.[5] T. TANIMOTO. *Report of the Committee-in-Charge of the Expt. Station of the Hawaiian S.P.A.*, 1940-41, pp. 126-129.—Ti (*Cordyline terminalis*) root is the most promising source of levulose yet investigated, being there present in an almost pure form. This sugar is believed to hold great possibilities as a sweetening agent; and to overcome its hygroscopic properties, it could be sold compressed into cubes. Ti is a hardy plant which can be cultivated under all conditions, though subject to nematode infestation in dry locations. It takes two to three years to fully mature.

Organic Synthesis of the Sugars (Reduction Products for Plastics Manufacture). W. L. MCCLEERY. *Report of the Committee-in-Charge of the Expt. Station of the Hawaiian S.P.A.*, 1940-41, pp. 128-129.—Reduction reactions of the sugars using Parr's high pressure hydrogenation apparatus have been studied, and derivatives of levulinic acid prepared. Plastics have been made from sugars and their derivatives, but have proved to be inferior in quality, compared with those produced well known ingredients on the market to-day.

Nitrogen Metabolism. DOUGLAS COOKE. *Report of the Committee-in-Charge of the Expt. Station of the Hawaiian S.P.A.*, 1940-41, pp. 114-118.—Reporting on the work done by the nitrogen metabolism laboratory of the Hawaiian S.P.A., the author says protein was found to be both the chief nitrogen compound in the cane plant and the principal form in which N was stored. Two days after nitrogen was given to N-starved plants, considerable protein had been formed in the roots. Five days afterwards it had been built up tremendously in all parts of the plant. Apparently protein is being built up in young leaves and breaking down in the old ones. Two tests for maturity were tried out in connexion with the large nitrogen experiment. These related to the chlorophyll content of the leaves and the hemicelluloses (the acid hydrolysable traction). They showed some promise and will be repeated.

Sugar Transformations in the Plant. CONSTANCE E. HARTT. *Report of the Committee-in-Charge of the Expt. Station of the Hawaiian S.P.A.*, 1940-41. pp. 118-123. —Experiments designed to learn something about the mechanism of the synthesis of sucrose in the cane plant have been continued using detached blades and roots, which organs make sucrose when supplied with simple sugar in the dark.[6] Experiments with detached blades have included the following subjects: albino blades; time of day; and effects of poisons, vitamins, co-enzymes, and other organic and inorganic additions. Tests have also been conducted with cut and ground blades, expressed juice, and submerged intact blades. Studies with detached roots include the effect of aeration both during synthesis and during growth.

Production of Citric Acid from Cane Sugar. JOSÉ P. ZALDIVAR.[7] *Philippine Agriculturist*, 1941, **29**, pp. 738-752.—In this article results are reported on the influence of different concentrations (from 0·1 to 200 mgrms. per litre) of ferric chloride and of zinc sulphate on the production of citric acid by the fermentation of 18 per cent. sugar solutions by means of *Aspergillus niger*. Results were negative, it being found that neither of these two salts had any effect in increasing or decreasing the citric acid producing capacity of the individual strains.

[1] *Sugar News*, **4**, pp. 239-239a. [2] *Philippine Agriculturist*, **24**, pp. 283-295. [3] *Sugar News*, **2**, pp. 575-585. [4] *Loc. cit.*
[5] *I.S.J.*, 1940, p. 264. [6] *I.S.J.*, 1941, p. 86. [7] Department of Agricultural Chemistry, University of the Philippines.

Abstracts of the International Society of Sugar Cane Technologists.

Under the scheme initiated by the International Society, a collection of abstracts of papers on agricultural and technical subjects is prepared monthly. A selection from these "Sugar Abstracts" has been made by us from the material last issued, and is printed below.

CANE AGRICULTURE.

POJ 2878 in British Guiana. L. S. BIRKETT. *Tropical Agriculture*, 1940, **17**, No. 12, pp. 233-235.

POJ 2878 has proved itself an excellent field cane in British Guiana. Yields of sugar per acre are somewhat higher than those obtained from Diamond 10, and it is more tolerant to extremes of flooding and drought. Among its outstanding advantages are its rapid germination and ability (by its rapid growth) to cover ground quickly and thereby reduce the cost of weeding.

Difficulty in clarifying the juices of POJ 2878 has been blamed on a deficiency of phosphoric acid compounds in the juice, and on the presence of immature shoots or tillers. The conditions under which clarification troubles were first widely experienced in British Guiana, are in direct contrast to this view, for during the 1940 drought the P_2O_5 content of the juice was higher than usual and the cane was singularly free from secondary shoots and tops. In fact, the cane ground was more mature (being of a higher sucrose content and lower in reducing sugars) than has ever been obtained since the introduction of chemical control in British Guiana.

One of the outstanding features of cane cultivation in British Guiana is the fact that climatic conditions and cultural practice militate against ripening, and the cane is seldom fully mature when reaped. The sucrose content is relatively low and the reducing sugars ratio high. It appears that in British Guiana, clarification troubles are to be expected with POJ 2878 when this variety attains maturity (as measured by the reducing sugars/pol. ratio), and that these troubles have been avoided in the past by reaping slightly immature cane. It should be remarked that in Java where this variety causes no outstanding clarification difficulties, close planting and irrigation are usual, practices which tend to prolong growth and hence reduce ripening. The comments by DAVIS as to the necessity of a plentiful water supply and adequate fertilizer additions to this variety for avoiding clarification troubles further support this view. Experience in British Guiana thus seems to dispose of the theory that deficiency of P_2O_5 and the presence of immature shoots or tillers are necessarily the cause of clarification difficulties with POJ 2878; at least the difficulties are not greater than with other varieties affected by those conditions. The real cause of the difficulty remains unknown.

Urea, Molasses and Cane Trash in Stock Feeding. L. E. HARRIS. *Hawaii Farm and Home*, 1941, **4**, No. 4, p. 13.

At the Hawaii Agricultural Experiment Station one lot of lambs was fed on a basal ration which did not contain enough protein to sustain growth. Another lot received the same ration, to which was added an amount of urea calculated to supply known amounts of protein. Both lots received the same weight of food. The results showed that the lambs receiving urea were able to grow. In discussing these results the author notes that feedstuffs high in protein command high prices in Hawaii. On the other hand, the nitrogen in urea is cheap. Since Hawaii has plenty of molasses to furnish energy and adequate sources of cheap roughage such as cane trash and napier grass, the use of urea to supplement the protein in costly concentrates should result in a marked economy. If the islands should be blockaded during the war, urea would be a valuable recourse.

BEET AGRICULTURE.

Revolution in the German Beet Industry. TH. ROEMER. *Zuckerrübenbau*, 1941, No. 1.

Two powerful movements have begun to give the German beet industry a radically different aspect. The first arises from a belated realization that the beet is the most productive of all farm crops in feed value. It is now being cultivated on a large scale for stock feed as well as for the manufacture of sugar. It is now planted in districts remote from sugar factories, where they are either siloed or converted into dry feed in drying plants erected for the purpose. The other movement is towards mechanization of cultural operations in the beet fields. This has proceeded to a point where one person on the best managed farms can do the amount of work formerly accomplished by two. This movement has still some distance to go among the smaller farmers, but is proceeding at an accelerating rate.

Depth of Ploughing and Beet Yields. L. DECOUX and J. VANDERWAEREN. *Public. Inst. Belge Amel. Betterave*, **8**, No. 4.

An experiment was made with three modes of ploughing: ordinary ploughing (8 in. deep), deep ploughing (10 in.), and ordinary ploughing (8 in.) plus subsoiling to 10 in. Each of these objects received three different applications of nitrogen:

0, 66, and 132 lbs. per acre. A further variation was introduced with fall ploughing and spring ploughing. Deep ploughing and ordinary ploughing plus subsoiling gave about 4·5 per cent. more sugar yield than ordinary ploughing, independently of the amount of nitrogen employed. Increasing the application of nitrogen to 132 lbs. gave the greatest yield of beet plus tops, but the beets contained less sugar per acre.

Beet Nematodes in Belgium. L. DECOUX and M. SIMON. *Public. Inst. Belge Amel. Betterave*, **8**, No. 4.

Out of 1723 samples of dirt taken from cars and wagons used for transporting sugar beets to the factories, 62·5 per cent. contained no cysts and were therefore free from nematodes; 35·7 per cent. had such a small number of cysts that nematodes could be regarded as not a serious factor in those soils, only 1·8 per cent. could be regarded as badly infested. One result of this investigation was a confirmation of a previous supposition that there is no relation of cause and effect between presence of nematodes in the soil on the one hand and losses inflicted by the yellows disease of sugar beets on the other.

BEET TECHNOLOGY.

Prevention of Fires in Dried Beet Pulp Stores.[1] A. AHRENS. *Deut. Zuckerind.*, 1940, **65**, No. 37, pp. 603-604.

Fires in dried beet pulp store-houses in Germany have been so frequent as to require the promulgation of official regulations for their prevention, the main points from which are as follows:

The whole of the pulp should be dried so that it will have a moisture content of 8 per cent. at most, and a product which does not meet this requirement must not be sent to storage. Every pulp-drying installation must have a sufficiently roomy cooling drum, and the hot product should be moved in open conveyors, preferably belt conveyors. The pulp should leave the drying plant at a temperature of at least 20 or 25°C. (68 to 77°F.).

As far as possible the dried and cooled pulp should be stored in bags, to assure good ventilation. It is indispensably necessary that the floor and walls of the warehouse (preferably of cement) be absolutely dry and protected from soil moisture by an insulating layer of tarred paper or asphalt. The roof must be watertight and windows must be kept closed in wet weather. The object of these precautions is to exclude moisture from any source.

Where it is necessary to store dried beet pulp in loose form it should not be piled very deep but spread over the largest available floor space; in that case (and even when storage is in bags) thermometers should be embedded in the mass so as to give prompt indication of a temperature rise. Smoking must be strictly prohibited. Each electric light in the warehouse (indirect lighting preferred) must be well protected and have a separate switch.

The precautions to prevent access of moisture must extend to the freight cars in which the product is shipped. In case a rising temperature in the stored pulp gives warning of an imminent fire, the factory manager should turn the situation over to the local fire wardens rather than allow unskilled workers to handle it. The chief danger here is that a sudden access of air to the heated spot will provoke a burst of flame.

Action of Pozzulane Earths and Bentonite on Sugar Juices. M. GARINO and E. AFFERNI. *Ind. Sacc. Ital.*, **33**, pp. 233-239.

Pozzulanes and bentonite are zeolite minerals that have base-exchanging properties. In their experiments the authors treated beet juices of 11 to 12° Brix with these minerals, the total alkalinity being 0·023 to 0·025 per cent., figured as K_2O, and a total lime content of 0·040 to 0·050 per cent. CaO. The most favourable temperature was 50°C. and the full effect was obtained with no more than 1 per cent. of either mineral. Pozzulane is effective even in rather coarse grain; bentonite must be finely ground. The following percentual results were noted:—

	Pozzulane.		Bentonite.
Alkalinity decrease ..	64·86	..	32·25
CaO decrease	36·00	..	86·65
Purity increase	2·80	..	0·35

These improvements were for the most part maintained in the subsequent operations.

"Collactivit." G. KEPPELER and G. RADBRUCH. *Centr. Zuckerind.*, **48**, No. 45, pp. 799-801; No. 46, pp. 813-815; No. 47, pp. 829-831; No. 48, pp. 841-843; No. 49, pp. 869-872.

This paper deals extensively with the preparation and properties of a decolorizing material "Collactivit" made from peat and other materials by treatment with strong sulphuric acid. The peat dried to a moisture content of 15 per cent. is treated with 100 to 150 per cent. of its weight of concentrated sulphuric acid; dumped into water and the black mass washed until free from acid. The yield of "Collactivit" (dry) is around 72 per cent.

When no more than 100 to 150 per cent. of sulphuric acid is used the product will contain traces of free humic acids, which will give up colour to alkaline sugar solutions, but they may be destroyed if the proportion of sulphuric acid is raised to about 300 per cent. But the "Collactivit" thus produced contains a large proportion of exchangeable hydrogen, which would tend to lower the *pH* of the sugar juice and cause some inversion of sucrose.

It is found that by treating the finished "Collactivit" with milk-of-lime the humic acids are transformed into insoluble calcium humates that do not

[1] See also *I.S.J.*, 1941, p. 157.

add colour, while the decolorizing action of the "Collactivit" is not impaired. This treatment with lime diminishes the amount of exchangeable hydrogen in the material, and thus diminishes its direct ash-removing capabilities. However, it still retains its property of adsorbing cations by base exchange, which in this case means an exchange of calcium for potassium. This base-exchanging property is retained even when the peat "Collactivit" is dried to 18 per cent. moisture.

New Books and Bulletins.

Le Sol (Sol et Agriculture a l'Ile Maurice). J. DE BOUCHERVILLE BAISSAC. The Standard Printing Press, Port Louis. 1940.

The volume is written with the aim of popularizing the subject of the soil among the planters of Mauritius and is published under the auspices of the Sugar Industry Reserve Fund Committee. The work is divided into two parts. The first is of a general nature and describes the various types of rocks, with an especial note on the geology of Mauritius, the disintegration of these under mechanical and chemical influences and the physical constitution of the resulting soil. An account of the organic matter of the soil leads to a consideration of the colloidal properties, "climate," fauna and flora and the nitrogen in the soil. There follow four chapters on soil formation under different climatic conditions and the part concludes with a classification of soils. The second part is concerned with the soil in relation to agriculture and commences with an account of the plant's requirement as determined by analysis of the tissues, together with the influence of external conditions, air, temperature and light on the plant. Methods of agricultural investigation, including analysis and cultures, both pot and field, are then noted and followed by a brief account of agriculture in its relation to maintained fertility. The book concludes with a chapter devoted to the sugar cane and the cultural practices connected therewith.

Qualitative Chemical Analysis. ARTHUR I. VOGEL, D.Sc., F.I.C.[1] Second Edition. (Longmans, Green & Co., London). 1941. Price: 10s. 6d.

This book, the first edition of which was published in 1937, has had a good reception in this country. This is doubtless due to the excellent arrangement of the subject matter, and to the fact that it provides the student at a moderate cost with a sufficiently comprehensive text to be used throughout his study of the subject. Further, it is the opinion of its writer that the theoretical basis of qualitative analysis often neglected or but sparsely dealt with in other books merits equally detailed treatment with the purely practical side. He accordingly opens with a long chapter in which most of the theoretical principles finding application in the science are discussed.

Chapter II deals with analytical operations, on dry and wet reactions, and also includes a section on micro-analysis, and on the technique of micro-qualitative analysis, while also illustrating the apparatus most generally used. Chapters III and IV form the body of the book and are naturally devoted to the reactions of the metal ions (cations) and acid radicals (anions), and the tests commonly used for their identification. Chapter V outlines schemes for the systematic qualitative analysis of inorganic substances, and the concluding Chapter VII concerns the reactions of some of the so called "rarer elements." It is seen, therefore, that the ground is very fully covered. Indeed, Dr. VOGEL's book can be confidently recommended, not only to students, for whom it is primarily intended, but also to the practising analytical chemist, who will find it a *recueil* of modern qualitative tests and confirmatory reactions clearly and systematically arranged.

Feeding for Profit with Hawaiian Cane Molasses. (The Pacific Molasses Co., Ltd., of San Francisco, Cal., U.S.A.). 1941.

Large quantities of molasses from the mills in Hawaii are shipped by tankers to ports on the western seaboard of the U.S.A. and Canada for distribution by tank car and highway tank truck to farms, ranches and feedlots inland the year round. This pamphlet contains pertinent information of the methods used in feeding molasses to beef and dairy cattle, sheep and goats, hogs, horses and mules and poultry. It also gives directions for the preparation of cane molasses silage, and contains much useful general information on feeding practice and on the results obtainable with molasses feeding. An increasing practice is the spraying of cane molasses on fields of grain stubble and other less palatable forage, when it is found that animals then relish even the rough coarse grasses. This is likely to become a well established procedure in cattle feeding.

[1] Head of Chemistry Department, Woolwich Polytechnic, London.

Brevities.

On Measurement.—" When you can measure what you are speaking about, and express it in numbers, you know something about it; and when you cannot measure it, when you cannot express it in numbers, your knowledge is of a meagre and unsatisfactory kind. It may be the beginning of knowledge, but you have scarcely in your thought advanced to the stage of a science."—Lord Kelvin.

Peruvian Sugar Exports.—Exports of sugar from Peru for the first six months of 1941, according to A. N. Crosby of Lima, amounted to 180,730 metric tons telquel, which compares with the corresponding amount in 1940 of 163,581 tons and in 1939 of 98,049 tons. Most of the sugar went to Chile (60,982 tons as compared with 64,090 tons in 1940), U.S.A. (74,070 as against 22,235 tons), Bolivia (16,766 against 5,441 tons), and Finland (13,392 tons against nil).

West Indian Sugar Exports, 1940-41.—The latest estimates of the exports of sugar from the British West Indies for the 12 months ending 31st August, 1941, give a total of 533,639 tons. Of this 64,552 tons comes from Barbados, 136,950 tons from Jamaica, 105,469 tons from Trinidad, 60,222 tons from the Leeward and Windward Islands, 166,080 tons from British Guiana, and 366 tons from British Honduras. An additional 25,900 tons is expected to come from Barbados in the form of Fancy Molasses.

Hitler's New Order.—" What is this 'new order' which the Nazis seek to fasten first on Europe and if possible—for their ambitions are boundless—upon all the Continents of the globe? It is the rule of the *Herrenvolk*, the master-race, who are to put an end to democracy, to parliaments, to the fundamental freedoms and decencies of ordinary men and women, to the historic rights of nations, and give them in exchange the iron rule of Prussia, the universal goosestep, and a strict, efficient discipline enforced upon the working classes by the political police, with the German concentration camps and firing parties, now so busy in a dozen lands, always handy in the background. There is the new order."—*From a broadcast by Mr. Winston Churchill.*

Queensland Production Figures.—The sugar production figures for the 1940 season in Queensland are given officially as 758,841 tons 94 n.t. sugar. The British Government as in 1939 purchased the whole of the available export surplus, and the prices received for those two years were appreciably higher than those which had prevailed in the several preceding years. For the 1941 crop however the ability to dispose of any of the sugar overseas has become dependent on a difficult sugar situation, and sugar storage accommodation will have to be greatly augmented. Production this year is provisionally based on the same aggregate mill peaks as in the past two years, which should allow for a crop of 737,000 tons of sugar; but while the peak quantities are left as before, the price to be paid is lower. At the same time the industry is warned that it should advisedly restrict its future crops by an agreed percentage, as, later on, crop control may be enforced, under which in 1942 less than the full peak would be acquired by the Government if there was not the market for it.

U.S.A. Per Capita Consumption.—Of three common articles of food consumed in the United States, official statistics show that sugar has a per capita consumption of 105 lbs. annually, coffee one of 15 lbs. and tea only 0·77 lb.

Recent "World" Prices for Sugar.—According to Lamborn, the average world price for raw sugar, converted to a New York basis, during July was 1·629 cents per lb., which compares with 1·304 cents for June and 1·171 cents for July, 1940. For the first seven months of 1941 the price has averaged 1·241 cents, as against 1·586 cents for the corresponding period of 1940.

Industrial Alcohol Production in U.S.A.—According to the U.S. Department of Commerce, the production of industrial alcohol in the United States during 1940 amounted to 243,727,756 proof galls., the number of plants in operation being 37. This quantity represents an increase of 42,710,210 galls. over the 1939 output. Of the materials used, molasses comes easily first with 194,601,368 galls., while corn is next with 136,815,670 lbs. As compared with 1939, there is an increased use of molasses and a decrease in the resort to corn.

Iran.—The recent landing of British troops in Iran at Bardar Shapur at the head of the Persian Gulf draws from Mr. Noël Deerr the reminder that "in Gondev (sc. Bardar) Shapur was the seat of the justly famous High School of Natural Science (conducted by the community of Nestorian Christians about 650 A.D.), whence came the most learned physicians, and it is certain that the studies pursued there contributed to the progress of industry and commerce. The first knowledge of sugar refining came from there and found its earliest application on the soil of Chuzistan."[1]

Dextrose Production in U.S.A. — American cane sugar producers have lately been demanding the control of dextrose production which in the form of corn syrup has displaced an enormous quantity of cane sugar in the preparation of preserves. Originally this use of dextrose was comparatively negligible, mainly because consumers believed that preserves prepared with corn syrup were inferior in quality to those made with cane sugar. However, with the discovery and boosting of certain vitamins in corn syrup, the production and consumption of dextrose has increased by leaps and bounds, and its uncontrolled production is claimed to be competing unequally with that of cane sugar which labours under many restrictive measures.

South African Sugar Production, 1940-41.—The final figures for the 1940-41 sugar crop in South Africa are 572,880 short tons, which contrasts with 595,556 tons in 1939-40 and 522,732 tons in 1938-39. Consumption has increased by 13 per cent. and amounted to 330,151 tons (against 292,033 tons). Exports came to 234,025 tons, compared with 308,763 tons in 1939-40 and 223,811 tons in 1938-39. The export price f.a.s. of 96° pol. sugar per 100 lbs. was 9s. 2·7d., as compared with 8s. 1·2d. in 1939-40 and 6s. 7·36d. in 1938-39. In the past ten years consumption in South Africa has increased from 185,000 tons per annum to over 330,000 tons. The consumption of second grade sugar included in above figures amounted to 88,586 tons, having just doubled in quantity in the course of four years.[2]

1 Quoted from Kremer (Culturgeschichte des Orients unter der Kalifen, I, p. 295). Vienna, 1875. 2 Figures from *S.A. Sugar Jl.*

Sugar-House Practice.

Bagasse Furnace Operation and Design.[1] K. S. Arnold. *Proc. 9th Conv. Sugar Tech. Assoc. India*, pp. 108-126.

Design.—In these notes the step-grate furnace only is considered since this is the type almost exclusively employed in India at the present time. Power-driven rotary feeders working in conjunction with a return type bagasse carrier provide the most satisfactory bagasse feeding arrangement. Apart from the convenience and considerable saving in labour compared with manual feeding and the entire absence of stored bagasse in the boiler house, the rotary feeder effectively prevents undue air leakage, and ensures a constant and evenly distributed flow of bagasse to the grate with only a normal supervision.

So as to favour the drying of the bagasse as it proceeds down the grate, it is recommended that the face of the check wall be made to slope forward towards the grate, the flames thus being thrown back so as to radiate heat towards the top of the fuel bed. A slope of 45° was found to give the most satisfactory results. When the vertical type of feeding opening is employed, a curtain wall should be provided above the top of the grate so that cold air entering the furnace with the bagasse cannot escape along the roof and thus exercise a cooling effect on the brickwork.

As to the grate area, in India the ratios adopted generally lie between 1 : 50 and 1 : 60, which are low compared with most other countries, meaning that the grate areas are larger than elsewhere. Generally the angle of slope of the grate is 52°, as copied from results found in Java with the Proefstation type of grate, but the slope which will give the best results in a specific case is best found by trial under working condition. The top of the grate should be provided with a dead-plate over which the incoming bagasse may slide for some distance before reaching the grate bars.

In the grate construction generally found in India, the bars are supported between the bearers on small projecting ledges cast to the sides of the latter. Of importance is the frictional resistance offered to the free downward flow of bagasse by the upper faces of these bearers. In an improved design the upper edge of the bearers is provided with specially shaped slots into which the fire-bars can be slipped and locked in position by small projecting lugs on the bars. With this design the bearers do not come into contact with the fuel at all, none is placed near to the walls and the incoming air passes right round them.

In the majority of furnaces only the fire bars can be removed, so that when entering the chamber it is necessary to clamber between bearers and over supporting beams. It is a simple matter for these to be also removable. The bearers are arranged to rest against the furnace wall at their upper ends, and to hook over the supporting beam below, the supporting beam in turn being made so that it may be withdrawn through a hole provided in the side wall of the furnace. Moreover, it is difficult to arrange that the removable type of grate be so adapted that its angle may be made variable between limits, and readily altered while the furnace is working. Plain flat grate bars are more satisfactory than the lipped type. Raking the firebars at frequent intervals interferes with combustion by disturbing the even flow of the bagasse, and also results in loss due to unburnt fuel being deposited in the ash pit. Provided that the grate is well designed, and a well regulated supply of bagasse delivered to the furnace, the downward movement of the fuel bed should proceed automatically, and the accumulation of ash on the bars should be small.

Leveller Knife Installation at South Johnstone Mill, Queensland. R. D. Clark. *Proc. Queensland Soc. Sugar Cane Tech., 12th Conf.*, pp. 167-170.

During the slack season of 1939 at South Johnstone the "National" shredder was removed and for the past two seasons knives only have been used for cane preparation. There are two knife units, one at approximately ground level, and the other at the top of the carrier. Both sets have the same number of knives which are all hooked. The bottom knives have a clearance of 12 in. from the carrier boards, and the top set has a clearance of ¾ in.

Alterations made to the original design[2] consist in the main of an 8 in. diam. shaft with a fixed key fitted for a length of 5 ft. 3½ in. Thus the discs have only to be bored to fit the shaft and a keyway machined in each disc. Previously each disc was machined to fit a 5 in. octagonal shaft. Consequently much time and labour is saved by simply machining an 8 in. diam. hole and keyway. As the above remarks apply to the cast-iron distance pieces also, it will be readily acknowledged that much labour is saved by the later design.

The electric motors are now direct coupled to the knife shaft through a flexible coupling, which eliminates the belt drives used previously and avoids trouble with slipping belts and hot countershaft bearings. Warning lights and ammeters are fitted directly in front of the clutchman, so that should either unit become heavily loaded, due to irregular carrier feed or hard cane, a red light flashes and draws the clutchman's attention to the particular unit that is overloaded. The clutchman is thus able to "nurse" the feed through the knives until the ammeter indicates normal loading of the motor.

The bottom unit is connected to a 200 h.p. motor running at 750 r.p.m., with an average working load

[1] Continued from *I.S.J.*, 1941, p. 286.

[2] Proceedings of the 1934 Queensland Conference.

of approximately 120 h.p. The top unit is driven by a 150 h.p. motor running at 600 r.p.m., the average working load being approximately 100 h.p. Both units are fitted with roller bearings which have given exceptionally good results. Previously white metal, water-cooled bearings were in use but could never be relied upon to the extent enjoyed with roller bearings.

"Tramp iron" gives considerable bother and nearly all knife breakages can be attributed directly to this cause. One advantage of a large bottom knife unit is that it frequently gives a warning of tramp iron which would otherwise not be noticeable until entering the top unit. The knife blades are of spring steel.

One important factor which must not be overlooked is the care necessary when assembling a new unit, or at week-ends when inspection of both units occurs. It has been found advantageous to inspect both units each week-end for cracked knife blades and loose bolts. Every second week-end a complete set of knives is fitted. These have been carefully weighed and the weight of each knife marked, to facilitate the balancing of the unit. The knives removed are drawn out and repaired during the week and become a part of the other unit the next week-end.

Care is taken when assembling a complete new unit that all distance pieces and discs are balanced correctly both before and after assembly. The knives are fitted according to their weights, i.e., a 10 lb. knife must be fitted opposite a knife of equal weight. These facts have emerged after six years' continuous use of this type of knife unit: (1) Roller bearings definitely improve performance; (2) a heavy shaft gives much less vibration and less risk of a bent shaft through striking tramp iron; and (3) knife replacement is speedy and balancing is simple. For the past two seasons it has been found possible to operate successfully without the use of the shredder, on a crop containing approximately 99 per cent. Badila.

Results obtained with the Continuous Pressure Feeder in Queensland. THE NORTHERN INSTITUTE OF SUGAR TECHNOLOGISTS. *Proc. Queensland Soc. Sugar Cane Tech.*, 12*th Conf.*, pp. 165-166.

A continuous pressure feeder was installed in front of the fourth or last mill at Mossman for the 1940 season.[1] It was driven from the fourth mill engine through a ring gear, attached to the side of the main gear wheel, driving a smaller wheel mounted on a shaft connected to the bottom feed roller through a tail shaft and couplings. The usual drive in previous installations has been from the pintle end of the mill top roller to the feeder top roller.

Due to irregular feed and incorrect feeder and mill settings, the results of the first few weeks' crushing were somewhat disappointing. The former was the main trouble, mainly because of the steep angle of the intermediate carrier, which caused the bagasse to pack against the rakes. A better feed was obtained by increasing the speed of the carrier.

For a period of seven weeks after the adjustment of the disabilities referred to, the average moisture content of the final bagasse was 44·64 per cent. The following moistures per cent. obtained from snap samples of bagasse of different cane varieties may be of interest :—

POJ 2878.		Badila.	HQ 426.	SJ 4.
36·4	37·2	44·5	47·2	42·4

When crushing the same amount of fibre per hour as in the previous season the roller speed was lower and the mill settings closer, the comparative figures for the two seasons being as follows :—

Season.	Roller speed. Ft. per min.	Mill set openings. Feed. in.	Del. in.
1939......	21·5	$\frac{3}{8}$	3/32
1940......	19·2	$\frac{1}{4}$	0

The pressure feeder set opening in 1940 was $\frac{15}{16}$ in.

As a result of the experience gained during the season, it was concluded that the pressure feeder has made it possible for an increased extraction and a lower moisture in bagasse, even with reduced roller speed and a floating top roller on the final mill. Heavy maceration could be carried and closer mill settings used, although the power required to drive the mill and pressure feeder was greater than that required by the mill and two pushers in the previous season.

The lower moisture in bagasse improved combustion and assisted in maintaining a steady steam supply for the factory. More cush-cush was dropped from the combined mill and feeder, but as more juice was available to wash it from the mill bed to the chokeless pumps, no trouble was experienced. It is concluded that a feeder installed between mills with only 31 ft. centres, necessitating an intermediate carrier set at an angle of 55½° from the horizontal will work satisfactorily, and that no alteration to the standard design of carrier is necessary.

These remarks apply, of course, only to the experience gained during the first year and may need amendment to cover the varying seasonal influence. In conclusion, the main reasons for installing the pressure feeder were to increase the efficiency of the crushing plant and to provide a drier bagasse feed to the furnaces in order to ensure a steady steam supply to the factory. Judged in accordance with these conditions, the installation has been quite successful.

Production of High-quality Raw Sugar from *C*-massecuites. E. F. ECHENIQUE. *Sugar*, 1941, **36**, No. 4, pp. 26-27.

High quality *C*-sugar can be produced in one operation for use as "seed" grain in the manufacture of raw sugar, the refining quality of which in regard

[1] *I.S.J.*, 1940, p. 153.

to colour and filtrability is thus definitely increased. This is done by using modern high-speed centrifugals and accessory equipment, the essentials of the operations involved being as follows :—

(1) Rapid heating of the cooled massecuite in the mixer to the saturation temperature, which (for Cuba) usually varies between 130 and 135°F. (54 and 58°C.), the heating equipment used having the ability to re-heat with a minimum temperature differential between the final massecuite temperature, 130 to 132°F. and the heating medium. 135 to 165°F..

(2) Use of high-speed centrifugals with full automatic equipment and sufficient capacity to allow cycles ranging from 12 to 20 min., depending on the grain characteristics and machine speeds. Automatic control of the components of the cycle is essential from the standpoint of uniform results, as maximum difference between purity and volume of final molasses and wash-syrup.

(3) High temperature wash-water system, preferably a steam water combination. A high temperature mist is essential for uniform and minimum washing, the temperature of the wash-water striking the sugar wall being higher than that of the sugar, so as to avoid a congealing effect in the case of lower purity sugars.

(4) Automatic syrup separation equipment to eliminate any wash-syrup passing into the final molasses, the separation being definite and automatically controlled, in order to operate at the proper point after molasses elimination and when washing operations commence.

(5) *C*-massecuites used should be free from very fine or smear grain, as such massecuites cannot be sufficiently purged to produce a sugar that can be washed in the centrifugals. "Skin" formation which has been observed on the centrifugal wall in the basket is definite proof of the presence of badly mixed or smear grain or both in the massecuite. Such a sugar cannot be properly washed and a low purity sugar results, even on a prolonged cycle.

Efficiency of the process in the production of a high purity "seed" is shown in the small difference between the purity of the mother-syrup and that of the final molasses. This difference is less than 1°, and in most installations has been kept to approximately 0·5°. Advantages and economies of this equipment in addition to the production of a raw sugar of improved colour and filtrability may be summed up as follows :—

Amount of impurities and volume of seed magma returned to the head of the pan boiling system is materially reduced. In cases where the pan capacity is "bottle-neck," this has permitted increased grinding by supplying more syrup to replace the volume of material previously introduced from the low purity *C*-sugar. Labour is economized, as one operator can handle as many as ten automatic machines on a 15-min. cycle. Sugar lost in the final molasses is diminished by the re-circulation of much less non-sugars back into process. Quantity of massecuites to be boiled for a given raw sugar production is materially reduced, which simultaneously increases both pan and crystallizer capacities.

Mauritius : Report of the Sugar Technologist. LOUIS BAISSAC. *Annual Report of the Department of Agriculture for* 1939.—A complex process of clarification was applied in a factory in the northern part of the Island, a Bach continuous juice subsider forming part of the necessary installation. Among the advantages resulting from this arrangement were that the factory crushed at full capacity in spite of the refractory nature of the juice ; the loss of sucrose in the filter-press cake was reduced by about 50 per cent. ; and the juice was so clear that filtration through Philippe filters was no longer necessary. Comparisons were made in factories of the *pH* value as determined : (a) electrometrically using a glass electrode *pH* meter, and (b) colorimetrically, using the Hellige apparatus. Conclusions arrived at were that there was perfect agreement between the two sets of readings for undiluted juice and syrup ; when in the colorimetric method dilutions of 1 in 5 were used for the juice and 1 in 10 for the syrup the readings were 0·3 to 0·5 higher as compared with the electrometric method. This difference is attributable to the change due to dilution and not to the method itself. Final mutual control figures show an average sucrose content of 12·71 per cent. cane, as compared with 13·87 and 12·99 in 1938 and 1937 respectively, this being the lowest figure on record for the past 13 years. Recovery was 1·5 lower than in 1938 on an 85 per cent. purity basis.

Operation of a Sugar Bureau Automatic pH Controller. A. SHEARER. *Proc. Queensland Soc. Sugar Cane Tech. 12th Conf.*, pp. 67-74.—A report on the operation of an automatic *pH* controller at Moreton Mill, Queensland, is here given.[1] It was found that the greatest manifestation of the benefits of automatic control was in the functioning of the subsider equipment. With the higher crushing rate which occurred, and an 18 per cent. increase in canes yielding refractory juices, improvement in subsider performance must have been due primarily to the automatic control providing optimum *pH* conditions for subsequent juice subsidation. However, the clarification system as well as the *pH* control values had an influence, so that the criteria of clarification efficiency (as purity rise, mixed juice to clarified juice) would not be a result of the operation of the *pH* controller, except in so far as the constancy of the purity rise was concerned. Results based on observation, comparison of *pH* values, ease of operation and elimination of haphazard control, definitely justify automatic *pH* control.

1 For reports of previous work see *I.S.J.*, 1937, p. 119 ; 1939, p. 29 ; 1940, p. 28.

Stock Exchange Quotations of Sugar Company Shares.

LONDON.

Company.	Quotation September 22nd 1941		Quotation August 20th 1941		1941 Dealings Highest	Lowest.
Anglo-Ceylon & General Estates Co. (Ord. Stock) ..	25/0 — 26/3	..	23/3 — 24/6	..	25/9	— 23/9
Antigua Sugar Factory Ltd. (£1 Shares)	$\frac{1}{2}$ — $\frac{3}{4}$	..	$\frac{3}{8}$ — $\frac{5}{8}$	..	11/3	— 8/9
Booker Bros., McConnell & Co. Ltd. (£1 Shares)....	$2\frac{3}{8}$ — $2\frac{5}{8}$	..	$2\frac{3}{8}$ — $2\frac{5}{8}$	..	52/6	— 47/6
Caroni Ltd. (2/0 Ord. Shares)	1/3 — 1/9	..	1/3 — 1/9	..	$1/7\frac{1}{2}$	— $11\frac{1}{4}$
(6% Cum. Pref. £1 Shares)	21/0 — 22/0	..	21/0 — 22/0	..	22/6	— 20/3
Gledhow-Chaka's Kraal Sugar Co. Ltd. (£1 Shares)..	$1\frac{3}{16}$ — $1\frac{5}{16}$	..	$1\frac{3}{16}$ — $1\frac{5}{16}$	..	24/6	— 22/0
Hulett, Sir J. L. & Sons Ltd. (£1 Shares)	28/0 — 29/0	..	27/0 — 28/0	..	28/9	— $22/1\frac{1}{2}$
Incomati Estates Ltd. (£1 Shares)	$\frac{1}{8}$ — $\frac{1}{4}$	..	$\frac{1}{8}$ — $\frac{1}{4}$	..	4/0	— 3/6
Leach's Argentine Estates Ltd. (10/0 units of Stock)	7/0 — 8/0	..	5/9 — 6/3	..	6/9	— 5/0
Reynolds Bros. Ltd. (£1 Shares)	36/0 — 38/0	..	36/0 — 38/0	..	38/0	— $32/7\frac{1}{2}$
St. Kitts (London) Sugar Factory Ltd. (£1 Shares) ..	$1\frac{5}{8}$ — $1\frac{7}{8}$	..	$1\frac{5}{8}$ — $1\frac{7}{8}$	..	35/0	— 34/3
Ste. Madeleine Sugar Co. Ltd. (Ordinary Stock)	15/6 — 16/6	..	14/9 — 15/9	..	15/6	— 11/9
Sena Sugar Estates Ltd. (10/0 Shares)	5/6 — 6/0	..	5/9 xd 6/3	..	6/6	— 4/0
Tate & Lyle Ltd. (£1 Shares)	58/0 — 59/0	..	54/6 — 55/6	..	$58/4\frac{1}{2}$	— 46/0
Trinidad Sugar Estates Ltd. (Ord 5/0 units of Stock)	5/3 — 5/9	..	5/6 — 6/0	..	5/9	— 5/0
United Molasses Co. Ltd. (6/8d. units of Stock)	26/6 — 27/0	..	26/6 — 27/0	..	27/0	— 21/9

NEW YORK (Common Shares).†

Name of Stock.	Par Value.		Closing Price August 30th, 1941		1941. Highest for the Year		Lowest for the Year.
American Crystal Sugar Co.	No par	....	$18\frac{1}{8}$	..	$19\frac{1}{2}$	..	$9\frac{1}{2}$
American Sugar Refining Co.	$100	....	$18\frac{5}{8}$	..	$20\frac{5}{8}$	..	13
Central Aguirre Associates	No par	....	$17\frac{1}{2}$	..	$22\frac{3}{4}$	..	$15\frac{1}{2}$
Cuban American Sugar Co.	$10	....	7	..	8	..	$3\frac{1}{2}$
Great Western Sugar Co.	No par	....	$26\frac{1}{4}$	..	28	..	$19\frac{7}{8}$
South Puerto Rico Sugar Co.	No par	....	$18\frac{3}{8}$	..	21	..	13

† Quotations are in American dollars and fractions thereof.

United States, All Ports.

(Willett & Gray)

	1941 Long Tons.		1940 Long Tons		1939 Long Tons
Total Receipts, January 1st to August 16th	3,277,507	....	2,546,536	....	2,544,411
Meltings by Refiners " "	2,962,354	....	2,466,553	....	2,409,252
Importers' Stock, August 16th	144,647	....	71,941	....	36,181
Refiners' Stock " "	437,201	....	444,611	....	298,960
Total Stock " "	581,848	....	516,552	....	335,141
	1940		1939		1938
Total Consumption for twelve months	5,712,587	....	5,648,513	....	5,604,051

Cuba.

(Willett & Gray)

	1941 Spanish Tons		1940 Spanish Tons		1939 Spanish Tons
Carry-over from previous crops........................	1,184,393	....	588,293	....	729,172
Less Sugar for Conversion to Molasses	80,941	....	— —	....	— —
	1,103,452	....	588,293	....	729,172
Authorised Production	2,399,004	....	2,753,903	....	2,696,517
	3,502,456	....	3,342,196	....	3,425,689
Exports since January 1st	1,976,240	....	1,618,824	....	1,675,761
Stock (entire Island) August 16th	1,526,216	....	1,723,372	....	1,749,928

The Market in New York.

A few days after our last report was written, the United States Administration announced a further increase in the U.S. domestic quota of 889,411 long tons, thus bringing the total to 8,038,370 long tons which represents an increase of 36 per cent. over the initial quota figure of 5,907,871 tons. The only information we have of the various allocations so far is that the Cuban share has been increased by an additional 335,365 tons to 2,455,768 tons, which is 21,448 tons in excess of the entire 1941 production of 2,434,320 long tons (including 405,720 long tons special financed reserve). It will be seen from the above figures that stocks in Cuba will be very considerably reduced and we estimate the position as follows :—

	Long Tons	Long Tons
Carryover from previous crops..		1,201,330
1941 production		2,434,320
		3,635,650
U.S. quota	2,455,768	
Estimated sales so far to non-U.S. destinations	650,000	
Local Cuban consumption......	150,000	
Converted to Molasses	100,000	3,355,768
Balance....		279,882

It is, of course, not certain that Cuba will ship the entire quota to the United States, as this will depend to some extent on the availability of supplies from other sources combined with the amount of stocking up taking place in the U.S.

The further outlet for Cuba was not without effect upon the World price as reflected in the New York Number 4 Contract and, assisted by moderate sales to the United Kingdom which, according to reports, brings the total U.K. purchases to around 500,000 tons, a new high level was reached on September 8th when 2·17½ c. f.o.b. was quoted for December delivery. Subsequently, the market held fairly steady but quieter with quotations fluctuating slightly at a little below the best, but since September 23rd the tendency has again been towards higher levels and at the close on September 25th, December had reached 2·33c. f.o.b. which is above the parity of the American market.

As far as can be gathered, the latest increase in the quota had little effect upon the domestic market where the view is held that the quota system is now virtually in suspense, the primary consideration at the moment being not so much a question of sugar supplies, which on paper appear to exceed requirements, but whether sufficient shipping will be available. The maximum price of 3·50 c. c.i.f. established on August 12th prevented any business being done above that figure and the Spot quotation eventually dropped to 3·50 c. after having remained nominally at 3·80 c. for about three weeks. On September 8th however, it was announced that the Cuban Institute had sold 350,000 tons to the United States at 2·22 c. f.o.b. which, it was stated, was the maximum price possible with a duty of 0·90 c. and freight at 0·38 c. No mention was made of insurance, landing and supervision costs, however, which presumably are to be for account of buyers and if this is the case the maximum price of 3·50 c. c.i.f. duty-paid will be exceeded by a few points.

Latest reports available indicate that Refined quotations were increased to 5·20 c. during the early days of August after considerable business had been done at 5·05 c., whilst a further advance to 5·35 c. was recorded a few days later but no new demand appears to have developed prior thereto.

C. CZARNIKOW LTD.

London, E.C.3.
26th August, 1941.

COLD-RESISTANT CANES.—Some time ago the United States Dept. of Agriculture imported some cold-resistant wild canes from Turkestan, a variety that will continue to thrive in spite of snow lying thickly on the ground. Their sugar content is only nominal, although they belong to the same family as the commercial sugar cane. After overcoming many difficulties, the U.S. Department of Agriculture succeeded in crossing these canes with ordinary sugar cane, and later these half-breed seedlings were back-crossed to sugar cane.[1] The progeny of this cross, while considerably less resistant to cold than the original wild parent are nevertheless much more resistant to frost than ordinary commercial varieties, and the results of further back-crossing are looked forward to with interest. The Queensland Bureau of Sugar Experiment Stations has lately imported, through the courtesy of Dr. Brandes, two of these Turkestan half-breeds and three quarter-breeds, and these are being grown in the quarantine house at Brisbane and will be transferred to the cane breeding plot in 1942.

CLAIMS MADE FOR DEXTROSE.—Some of the claims made for dextrose as a food have been noted recently.[2] Stuart O. Landry[3] calls attention to the propaganda being carried out in the U.S. for the purpose of displacing the use of ordinary cane sugar (sucrose) in the confectionery, baking and canning industries. In short, the public is given the impression that it should stop using refined cane sugar, and should use dextrose in its place. Now the latest stroke is to declare that dextrose is the "all American sugar," not a single pound sold being imported. Mr. Landry's reply to this is that if it replaces cane sugar in so many instances it should come under the quota system, its production and distribution being controlled and directed as is that of refined cane and beet sugars in the U.S. In any case, research should be instituted into the question of the relative merits of sucrose *vs.* dextrose as foods and as materials for use in different manufactures. Cane and beet interests in the U.S. should not allow the dextrose producers to get away with claims which may be of doubtful value.

1 For more technical details of this breeding for cold resistance see *I.S.J.*, 1940, p. 161.
2 *I.S.J.*, 1940, p. 228. 3 *The Sugar Journal* (Louisiana), 1940, 3, No. 7, pp. 5–6.

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Notes and Comments.

The War.

As we write these lines, the German invasion of Russia has lasted exactly four months and though the Germans have overrun vast amounts of territory, including a number of important manufacturing cities, they have not succeeded so far in their main aim which, according to HITLER himself, was the complete destruction of the Soviet armies and the elimination of Russia as a fighting force. But the losses on both sides have been very heavy and while Russia can probably stand longer the drain on personnel, it is certain that Germany, with all the arsenals and factories of Europe at her beck and call, can produce the necessary material to a degree that Russia cannot match. Therein lies the importance of England and the United States coming to the aid of the Soviets with all the supplies of munitions and instruments of war that they can possibly produce and get to their destination. This is the main task for the two big Democratic countries during the next 12 months, and on the degree of the support they thus give hangs the question whether the German land forces can be worn down and defeated in Eastern Europe and the Middle East, or whether HITLER will succeed in eliminating that front and be able to devote his remaining still very large forces to operations in Western Europe, in particular to the invasion of Great Britain, a task which remains, in the opinion of experts, by no means impossible, providing the German command is prepared to throw away vast numbers of men in the attempt. So long as this danger exists, the United Kingdom must remain a fortress, equipped in men and material for any emergency, for this country forms the keystone of the Allied arch and its fall would bring down the whole edifice and leave the United States eventually as the sole haven of democracy in a Nazi-controlled world. And then how long would that haven survive, one wonders ?

The assumption we made last month that the German armies on the centre front in Russia were only temporarily held up proves to have been the case, for the march on Moscow was soon resumed, after some weeks of inactivity while Leningrad was assailed and further portions of the Ukraine were overrun. This fresh attack on Moscow, directed from several points of the compass, has been described as the biggest battle the world has ever seen. Unlike Leningrad, Moscow has no sheet of water to guard one of its flanks and the risks of envelopment are correspondingly greater. But in spite of some three weeks of ferocious attack by the Nazi hosts, the Russians have been able to put up a stout defence, and at the moment of writing the enemy is thought to be showing signs of exhaustion and may yet be successfully held off from seizing the Soviet capital till the arrival of winter makes major operations a comparative impossibility. Much depends, necessarily, on the degree of exhaustion reached by the Russians themselves, and Moscow remains in sufficient danger to warrant the recent exodus of the Diplomatic Corps and the Government offices to another city several hundred miles further east. But the advantages of preventing the Germans from securing such a base for wintering in are manifest to all beholders of the struggle, and if the Russians can retain their capital and leave their enemy to camp outside in the cold, in more senses than one, the wastage facing the German containing forces will be considerable and the setback self-evident. This is also so obvious to the Germans that they may shoot yet another bolt, if they are capable of it while the weather conditions allow.

But if the fast approaching winter brings along a slackening of the warfare in central and northern Russia, the southern section remains open to continuing major operations on the part of the German command, and there the obvious incentive is to invade the oil centres if they can, but otherwise to try and cut off the entry into Russia from the Caucasus and to stop the Allied supply of munitions beginning to pour in through Persia. So far the Russian southern command has been the weakest of the three facing the Germans, and has had to retreat the furthest ; but here the Nazi lines of communication are the most extended and will be the more

vulnerable to counter-attacks if the Russians can produce the necessary forces. The Germans have not yet quite skirted the Sea of Azov so as to descend on the mountain fastnesses of the Caucasus, but if they secure Rostov at the eastern corner they will necessarily cut the chief railway line from the Caucasus into Russia. Italian papers credit the British Middle East forces with the task of fortifying this mountainous approach to the south. If this is done, the obvious alternative route to the oilfields for the Germans lies through Turkey, and the latter accordingly remains in the same danger as previously of losing her neutrality. It seems unlikely that the Middle East will get through the winter without witnessing some fighting on a major scale, if German organization is still as unimpaired as it is credited with being.

Mr. CHURCHILL has lately told us that the German air force is suffering from a shortage—that is in relation to its widespread commitments, but that otherwise their military might is ample for other major wars, whether in the Middle East or in the Spanish peninsula with north Africa as the ultimate aim. The almost total immunity of Great Britain from air attacks since last May has been a measure of the Luftwaffe's concentration of its available forces on the Russian front; but once the Germans have to dig in on that front for the winter, their bombers are certain to seek old targets, unless indeed they are all wanted for a Blitzkrieg in the countries bordering the Mediterranean zone. The recent heavy bombing of Germany and France, whenever the weather permitted, has not only caused considerable destruction to German supply, but is credited with keeping about half the German fighter force tied to Western Europe. This and the development of supply to Russia has been the most that it has been feasible for Great Britain to undertake during the months that have seen Germany concentrating on crushing Russia. Any British invasion of the Continent is a matter of long planning and vast preparation and the time is not yet. Any modern expeditionary force is nothing if not fully mechanized and the number of motor vehicles from tanks to trucks which are needed for even a single armoured division is much greater than is generally realized. The Channel which protects England from land invasion presents equal difficulties in the opposite direction and the great amount of shipping necessitated to transport across the water sufficient forces to withstand a counter-attack of the usual German dimensions is probably not available at the present stage, when the existing British shipping has so many other calls on its services. The Russian defensive retreat has been wholly on land, but any retreat forced on an inadequate British invasion of enemy territory can only produce a second and more disastrous edition of Dunkirk. So the British Command must needs bide its time and wait till its equipment is more extensive.

The United States seems to be moving slowly but inexorably towards a "shooting war," and the Germans have lately helped to reduce further the diminishing opposition to the inevitable by torpedoing both naval and mercantile American vessels. Reports from the States suggest that Americans are already beginning to feel the pinch of war priorities, especially in consumable goods and in ordinary needs of life which are increasingly difficult to buy. This may or may not lead to some further vicissitudes in public opinion, but the tide as a whole is carrying the President along in the direction in which he has given his country a steady lead—the material support of world democracy in the titanic struggle while there is yet time for united action. The alternative is the danger that his country may some day be left alone to carry on that struggle.

Sugar Stocks in the United Kingdom.

In a speech he made in the House of Lords last month, Lord WOOLTON (the Minister of Food) said that we entered the third year of the war with better reserves of such things as wheat and sugar than we had held at any previous period since the war began. These bulky commodities were the foodstuffs that had made the heaviest demands on our shipping tonnage. The fact that we held big stocks of them was the best demonstration possible that we had been getting the better of the enemy in the Atlantic, a task in which we were receiving most valuable American aid. These two items of food did not, however, provide a balanced diet, such as we needed if we were to keep this country fighting fit. The balancing items were the things that had given us the most trouble to secure—such as meat, bacon, eggs, milk, cheese and dried fruits. Generally speaking, most of these items cannot be stored in large quantities, as many of them require cold storage. But a highly significant percentage of our requirements in these foods was now being sent to us by the United States, who were standing behind us in the matter. The comparatively short haulage across the Atlantic was an economy in the use of shipping worth a very large number of additional ships to us. But these particular foods were not being made available for us without very special efforts on the part of America, as they were not the type of goods that the United States had been accustomed to export in large quantities, so it needed extra effort on the part of the producers there to meet the new demands.

Thanks to this, Lord WOOLTON remarked, our level of food distribution was improving, but we would not be in any danger of living on a luxurious diet in this country, as rations must remain on the low side.[1] Still the bulk of the stocks we held of such things as wheat and sugar were our line of defence against starvation.

The above disclosure as to stocks of sugar being now better than at any time since the war broke out,

[1] At present the butter ration is but 2 oz. weekly, bacon 4 oz., meat 7 oz. on the plate, while as for eggs, 2 per head was last *month's* ration, apart from what the few who kept poultry could get.

coupled with the market reports from New York which assume that the total purchases of sugar from America by the British Sugar Control are in the neighbourhood of 500,000 tons, suggests that our stock position in this commodity is amply established and justifies the increase in the sugar ration by 50 per cent. for the winter months at least. As for stocks in existence on the outbreak of war, the last officially published figure was that of 373,000 tons on August 1st, 1939, but some of this may have been "segregated sugar," that is sugar of unknown quantity which the Government had commenced early in 1938 to store against emergency. In that year Mincing Lane thought that the amount to be segregated might be anything between 200,000 and 400,000 tons, though conservative opinion deemed that the lower figure was nearer the mark at the time. Possibly it was increased in 1939. Be this so or not, it seems a legitimate assumption that when the war broke out we had at least half a million tons of sugar in stock in this country and Lord Woolton's statement would seem to imply that we have at least that amount in store now. For a population of some 46 millions the half pound ration till now in force required about 534,000 tons a year; the extra ration of 4 oz. conceded during the winter months needs roughly 22,000 tons per month. It seems evident that the more recent policy on the part of the Sugar Control to buy largely from the Caribbean rather than draw exclusively from the more distant parts of the Empire has been justified in respect to shipping convenience, time of haul, and safety of cargoes, even if the price has been higher.

Of course the amount represented by the sugar ration is only a percentage of the total quantity of sugar needed for consumption in the United Kingdom. Besides domestic consumption there are the greatly augmented Services requirements, the sugar users' and the caterers' rations as well as the allowance for sugar cargoes lost by enemy action. An American statistician last Spring estimated the total annual requirements to be sent to this country or grown here as 1,257,350 long tons raw value, a quantity that is easily made up beyond the half million tons by Home beet and Empire purchases.

As a postscript to the above, the news comes to hand while we go to press that "large quantities of sugar taken from our stocks here in Great Britain" are being sent to Russia to alleviate the shortage there. The pronouncement as to record stocks in this country is so recent that it seems a fair inference that this aid to Russia is being given without lowering the minimum stock figure which we have postulated above, in other words that recent purchases and imports by the Sugar Control have been on a much larger scale. The need in Russia for sugar must be very acute, for out of an annual production of some 2,500,000 tons the greater quantity comes from the Ukraine and none of this latter can be available this year, the factories having almost certainly been destroyed in the retreat.

International Sugar Commission.

The International Sugar Agreement, which came into force on September 1st, 1937, and was to last for five years, is due to expire on August 31st, 1942. According to Article 50 of this Agreement, the Contracting Governments have to decide at least six months before the expiration of the measure whether it shall be continued for a further period and, if so, on what terms. In the event of unanimity not being attained, the Governments which desire to maintain the Agreement shall be entitled to do so as between themselves.

Last January 76 delegates out of a possible total of 100 attended a meeting of the International Sugar Council in London and voted unanimously in favour of the continuance of the agreement. More recently discussions have taken place in London, on the initiative of the British Government, between the representatives of all the accessible countries to prepare for a formal meeting for the adoption of a resolution extending the agreement for a further period. This meeting has yet to be held and in some quarters it is expected that it will at least renew the agreement till the end of the war in its present form.

As is known, the full operation of the Agreement was suspended through *force majeure* on the outbreak of war; but while individual countries departed from the strict terms of the pact in the course of obtaining or disposing of their sugar supplies, no party to the Agreement took the step of denouncing it and withdrawing; and those members able to meet in London carried on and took formal decisions regarding the export quotas during the first two war years.

In recording the latest step that is being taken, the *Economist* observes that the endeavour of the British Government to secure the continuance of the agreement is part of a more general policy, reflected in the prolongation of the international tin, tea and rubber control schemes, in spite of the fact that restriction of production has virtually ceased. Its basis is the desire to retain the collaboration of the Governments of the chief producing areas—and in the case of sugar also of the leading consuming countries—as this may prove of assistance in framing a post-war policy. The countries adhering to the sugar agreement have been working on a post-war reconstruction plan for the international sugar trade since last January. This work is done by a special sub-committee of the International Sugar Council under the chairmanship of Dr. G. H. C. HART, the chief Dutch delegate. The committee includes representatives of Australia, Cuba, the Dominican Republic, Holland, the United States and Great Britain.

It may be added that of the 21 signatories to the Agreement of 1937, the only countries that would be

unable to send representatives to the meetings in London during the war would appear to be Germany, France and Hungary. Of the other occupied countries in Europe, the Netherlands, Belgium, Poland, Czecho-slovakia and Yugoslavia possess exiled Governments functioning in London which are able to play a part in the proceedings.

British Beet Acreage, 1941.

It was officially stated last month that the area devoted to sugar beet in the United Kingdom during 1941 had amounted to some 350,000 acres. No official figures of the results of campaigns in this country since the war broke out have been released, and the last one of which there are details was the 1938-39 year. Hence only a rough guess can be made as to the sugar outturn in 1941. In the year 1936-37 when the acreage was about 355,000, the average sugar content of roots 17·3 and the tonnage of beet per acre 9·7, the sugar production was 521,944 tons white sugar equivalent. In 1939-40 which was a favourable season in respect to weather the tonnage of beet per acre averaged 10·14 which was a record for the industry. In view of the cold Spring this season which must have retarded germination and the vicissitudes of the recent summer weather, it seems unlikely that this last tonnage of roots per acre can be repeated in 1941. But on the basis of 1936-37 a total of sugar production slightly over 500,000 tons seems envisaged. For 1942 it is officially stated that an acreage of some 405,000 is hoped for. On the above basis, an outturn in the neighbourhood of 600,000 tons can then be expected, given average favourable conditions. (Compare 1934-35 when the acreage was 403,884, yield of beets per acre 10·1, sugar content of roots 17·1 and outturn of sugar 615,000 tons). It will be noted that the Home beet supply this year accordingly about equals the amount needed for the domestic ration of half a pound per head per week, which has ruled from the end of May, 1940, till the middle of this month.

British West Indies Sugar Conference, 1941.

A Conference was held in Jamaica at the end of June to discuss subjects of general importance to the sugar-producing colonies of the British West Indian area, including British Guiana. About twenty delegates were present from the various colonies and seven sessions took place under the chairmanship of the Hon. F. M. Kerr-Jarrett of Jamaica. During its formal meetings the Conference was attended and addressed by, *inter alia*, the Governor of Jamaica, Sir F. A. Stockdale (Comptroller of Development and Welfare in the B.W.I.), Mr. O. T. Faulkner (Principal of the Imperial College in Trinidad), and Mr. C. R. Stollmeyer (Trade Commissioner in Canada for the B.W.I.).

The subject for discussion which took up the most time was the constitution and formation of a British West Indies Sugar Association, the members of which are to be the various Sugar Associations in the different colonies and islands concerned. Subject to the approval of the other local associations, which could not be bound in advance by the visiting delegates, it was decided that such an Association should be formed. Another important subject engaging the attention of the Conference was Scientific Research for the Sugar Industry, which was considered in relation to (1) the proposed B.W.I. Sugar Association, (2) Sir Frank Stockdale's activities, and (3) the work done at the Imperial College of Tropical Agriculture in Trinidad. The question of reciprocal trade with Canada also came up for discussion.

In his address to the Conference Sir Frank Stockdale referred to his work as Comptroller for Development and Welfare in the B.W.I. and stressed that the economic problems there loomed large and would demand first attention ; but such problems could not be studied in isolation, since thought and attention must be given to those social problems which are bound up with economic production. But during a period of war action was necessarily slowed down and they, therefore, had to deal at the start with the more urgent problems. He trusted that he and his colleagues would be able to produce schemes which would lay the foundation for sounder development and for better social conditions in the Colonies.

As regards the sugar industry, Sir Frank said that every Commission which had gone out to examine economic and social conditions in the West Indies had stressed the fact that the sugar industry was really the life-blood of the West Indian colonies. There was undoubtedly, throughout the West Indies, need for collaboraton and co-operation, a desire for which was expressed by the meeting of the Conference. He personally had witnessed the fighting partisanship of the earlier meetings gradually disappear (as the representatives of the different colonies began to understand and have some knowledge of each other's problems) and develop into a spirit of co-operation and a desire to work and to think of the Colonial sugar industry as a whole. He hoped that the Conference was the beginning of the growth of such a spirit. In post-war reconstruction they were bound to have a number of very difficult problems to solve and if the West Indies, by getting together, could think as a whole and be prepared to act as a whole in solving these problems, they would be rendering very good service to themselves and to their area of the Empire.

Sir Frank also expressed the view that it was necessary to take a much wider view of sugar than had been taken in the past, when it was thought of only in terms of food for man. As food, the outlook was limited, but were there no fresh possibilities in the industrial sphere, for instance of growing sugar canes or even other grasses of high fibre content which could be used to produce paper pulp or for

other industrial purposes? The rubber industries had an elaborate system of production research in the East, and consumption research in the United Kingdom, but nothing similar was as yet being done with sugar and other carbohydrates. Yet the time might come when they would have to divide their sugar industry into the production of sugar for food, the production of alcohol, and also give consideration to outlets for the fibre.

British Exports.

We are asked to state that if British goods, made of raw materials in short supply owing to wartime conditions, are advertised in this journal, the fact should not be taken as an indication that they are necessarily available for export. As a matter of fact, the export of most of the British goods advertised in our pages is controlled under the export licensing system, which takes into account the origin of the raw materials used. Following the Lend-Lease Agreement, the British Government has undertaken that no materials of a type the use of which is being restricted in the U.S.A. on the grounds of short supply, and of which the United Kingdom obtains supplies from America, will be used in exports save in special cases. This fact should dispose of any suspicions (created by the existence of advertising which may have in view largely the maintenance of good will) that re-exports of raw materials in short supply are being made in competition with the goods of the country from which the raw materials directly or indirectly originate.

This statement is rendered advisable from the fact that there is a small section of the American public, chiefly among the Isolationists, who have voiced the suspicion that the British export trade is taking advantage of the facilities created by the Lend-Lease Agreement to develop its export trade in competition with America at a time when the latter is beginning to find that the priorities created over there for war material are interfering with the customary flow of American exports. There is no real foundation in fact for these suspicions, but it is desirable that they should not gain any ground in American circles, as the result would clearly be harmful to Anglo-American relations in respect to war supplies.

Light and Temperature.

In a recent issue of this Journal[1] an account was given of certain work in Hawaii on the influence of light on the growth of the sugar cane. Light was there shown to be the dominant factor in determining growth as summed up in final yield. The conclusions were based on comparisons of field growths under differential factors. Evidence bearing on the same point but from a distant part of the world and under very different conditions of experiment comes from the investigations of E. W. BRANDES and J. I. LAURITZEN.[2]

Observations on a group of wild and garden canes grown at various latitudes ranging from the equator to 40°N. suggested that maintenance of life in the sugar cane was dependent on a suitable balance between the light and temperature quotas and that maximum vegetative growth required special relationships between these. Following on preliminary experiments to find an artificial light with an intensity suitable for the growth under controlled conditions of different varieties of sugar cane, a group of varieties commonly used as parents were selected and grown in a series of chambers with controlled light, humidity and temperature; the first and last only being subjected to variation, light being supplied by 4 ft. fluorescent tubes and 100 watt Mazda lamps. Details of only three of the experiments are given and they include the results obtained with 11 varieties grown at 59°F. under three fluorescent and two Mazda bulbs, and at 78°F. under the same conditions of light as well as under eight fluorescent and four Mazda bulbs. Growth was continued for eight weeks and its measure was height/increment starting from an initial height of 16 in.

As might be expected, high temperatures and high light intensity have, generally speaking, yielded the greatest growth. But the striking fact is that, while low temperature and low light intensity have given a reduced growth, this growth is a balanced one, continued throughout the period. In marked contrast high temperature and low light intensity has led to severe dislocation in the functioning of the plant and, in many cases, to death. Further, the different varieties show marked contrasts in their reactions. While US 1694 grew 12·8 in. in the eight weeks under 8F and 4M at 78°F. and 1·8 in. under 3F and 2M at 59°F., CP 31/469 grew only 0·68 in. under the former, and 0·65 in. under the latter conditions. Under high temperature and low light intensity this latter variety had died out by the end of the experiment. Other varieties showed intermediate reactions but, under high temperature and low light, few grew after the fifth, and none after the sixth week. These results may have practical application in the choice of variety to suit the climatic conditions.

H. M. L.

[1] *I.S.J.*, 1941, p. 234. [2] *Sugar Bull.*, 18 (1940), 23, p. 3.

Specialization, Susceptibility and Symbiosis.

Specialization, or the adaptation of an organism so that it flourishes only in a restricted environment, is a common phenomenon in Nature and, the more it is investigated, the greater is the wonder it arouses. To-day little is heard of DARWIN, but the idea of the struggle for existence which he, particularly, popularized, still remains a central fact in organic evolution. What has changed as the result of modern investigation is not that idea but the ideas concerning the sources of the variability among individuals and species which provides the material on which the selective forces of that struggle can play. Any high degree of specialization would, under the circumstances, appear to be disadvantageous. The caterpillar which is restricted in its diet to a single species of plant must, one would have thought, run a greater risk of extermination than one which is omnivorous. Yet instances of such specialization are not uncommon. Nor are these phenomena restricted to organisms in a state of Nature, examples occur among cultivated plants as every farmer knows even if he fails to realize the fact. Any standard system of rotations with crops following each other in a definite succession is one, if not a very striking example. The basis of the rotation is a recuperative period, either a fallow, a leguminous crop or a manurial dressing followed by the crop responding best to the relatively rich soil, with the succeeding crops those which are better adapted to a relatively empoverished soil. A study of this subject leads to conclusions which have a bearing on many practical farming problems and is, in consequence, worth a few moments' consideration. If it is not possible here to give a full, detailed and annotated account of all the evidence bearing on the subject, the exigencies of the world situation must be pleaded as an excuse with the hope that there will be no unkindly readers to interpret this as a screen for what is, in fact, the real reason—laziness.

The first fact that even a cursory study of the subject of specialization brings to light is that it differs both in kind and degree. In kind, it may be in the direction of adaptation of an organism towards its inorganic environment or to its organic, in which latter case the reaction may be mutual. In degree, it may be slight or strongly marked. Nature itself has many examples to offer of both forms. The changes in the flora which take place in passing from the tropics through the temperate zones to the arctic circle or from low to high altitudes afford illustrations of the first form, in its slight manifestation, for the change is gradual; the extended distribution of one species, even through one or more continents, and the restriction of another to, may be, a few square miles, illustrates the same form in its strongly marked manifestation. In a narrower field, as the ecologist well knows, varying soil conditions may have a distinctive effect on the flora and here, perhaps, the first bearing of the subject on practical issues is found. There can be little doubt that large sums have been thrown away in opening up to cultivation lands in those large undeveloped spaces of the world, particularly in the tropics, only to find them unsuited for the purpose. In many of these cases the loss might have been avoided by a preliminary survey of the naturel flora, though it has to be admitted that frequently the available knowledge is, at the time, inadequate and is accumulated only as the result of experience.

Interaction between two organisms in Nature is, perhaps, best illustrated by such cases of pests as that noted above of the caterpillar. Whilo few caterpillars are omnivorous, those of different species exhibit wide ranges in the degree to which they limit themselves in their diet. More striking examples will be referred to below.

Specialization is, thus, seen to be inherent in Nature. As such, it has a fundamental bearing on agriculture, though, from its very prevalence, it is accepted as such by the farmer without recognition of the fact; as when he does not attempt to grow sugar cane in England or beet in the moist tropical lowlands. He accepts it, again, when he decides which variety of a particular crop he will grow as best suited to his land. He ought to accept it but, too frequently, does not through failure to realize the fact, when he determines the manurial dressing he will apply. The broad differences in the requirements of different crops are, perhaps, sufficiently understood, but there is much evidence accumulated in recent years to indicate that different varieties of one crop, such as sugar cane, vary considerably in their requirements of the different plant foods. Fertilizer dressings, therefore, should be adjusted primarily to the character of the soil but, secondarily, to the special requirements of the plant.

It is to the facts of specialization, too, that the plant breeder owes his position as an economic power in the agricultural industry. Man, working in conjunction with Nature on an empirical basis, has made use of these facts from very early times to extend the range of the economic cultivation of most crops by varietal selection. He has had to be content, however, with such varietal forms as Nature has thrown up and it has remained for the plant breeder to give direction to this work and of malice aforethought, so to speak, raise varieties adapted to the particular conditions under which it is desired to grow the crop. With the advancement of genetical knowledge and technique, the older order is in process of reversal; it is no longer entirely a question of "where are land and conditions to be found suitable for the growth of a desired crop," but "here are certain lands and conditions, adapt the crop to them."

Of this phase sugar cane is an excellent example. In the space of little more than two decades, to take one instance only, a vast modern industry of sugar production has been built up in northern India. It is true that cane was largely grown throughout the tract before, but the fact remains that the industry in its modern development and present scale owes its being to the creation by "nobilization" of varieties containing the valuable characters of the noble canes combined with the hardiness of *S. spontaneum*. Varietal specialization, too, is being employed in this crop to a growing extent to meet different requirements arising from local variations in soil and climate. Monoculture, in the sense of the cultivation of a single variety throughout any wide tract, is rapidly becoming the exception rather than the rule. Even in so small an area as Barbados resort is being made to a group of varieties while the tabulated statements of the varietal position in Jamaica[1] show well the growing tendency to make use of varietal specialization.

It is, however, in the matter of disease that specialization is found in its most intense and complex form; complex, because it is not specialization resulting from the moulding of one pliant body to a rigid frame but from the mutual interlocking of two pliant bodies, the host and the parasite, and, in some cases, even three, two hosts and one parasite. This is that branch of specialization which covers the phenomena of susceptibility and which plays so important a role in agriculture. Difficulty arises here from the fact that it is impossible to define with certainty the contribution of each organism to the harmony, if such a word be appropriate to the relationship between host and parasite.

Seen from the angle of parasitism as a whole, the same range is found in the degree of specialization. Though it is not possible with present knowledge to say that truly omnivorous or univorous (to use a word the dictionary does not admit) species of parasites exist, it is undoubtedly the case that the range of hosts attacked by different fungi or insects varies widely; and the adaptation may be so perfect that the slight differences characterizing varieties of the same species may be sufficient to account for immunity of the one, and susceptibility of another variety. It is, too, a specialization which shows itself not only as an association of a particular parasite with a particular host, but it may be with a particular organ of the host. To such a degree is this carried in the fungi that crop diseases are capable of being broadly classified according to the organ attacked.

If the facts of this specialization which limits the parasite to a small range of hosts, are more prominent among cultivated plants than in Nature, the reason is that, in Nature, a constant check is imposed both by the rarity of expanses under a single species and by the balance established between the numerous cohabiting species, a balance between host, parasite and hyper-parasite. Expanses of a single species are the rule in cultivation and afford the ideal environment for the rapid multiplication of the parasite until the disease assumes epidemic form. Especially is this the case when, owing to the conveyance of the parasite to a new country, it is free to develop without the control of the hyper-parasite.

If the facts of specialization combine with those of cultivation to emphasize the role of the parasite in causing disease, these same facts open the road to control, for the localized enemy is more readily exposed to attack than one which is ubiquitous. Many and varied have been the methods adopted for the control of disease, but they have one common denominator, namely, by a close study of the host-parasite relationship, to find that particular limit to the parasite's environment, imposed by its specialized adaptation, which offers the best point of advantage from which to direct the attack, and to attack it at that point. The method so indicated may be crude or involve highly technical control, and examples of most of the methods now commonly adopted are to be found in the experience of the sugar cane grower. As crude methods may be cited rogueing against mosaic and the burning of trash to destroy the larvae of borers. They are methods for the most part applicable where specialization is of a low order. Change in the environmental conditions so as to render them less favourable for the parasite offers another opportunity which forms the basis of the attack now being made on the locust by locating the centres of incipient swarming, determining the particular conditions which render these so favourable breeding grounds and seeing how these can be so altered as to render them less favourable. More particulate are such methods as steeping sets in hot water, dependent for success on a differential lethal temperature between host and parasite. Where alternate or alternative hosts are involved, the elimination or control of the less valuable one affords another line of attack used in the case of the maize-cane-mosaic, the wheat-barberry-rust and the cotton-other Malvaceous plants-stainer (*Dysdercus*) relationships. The list could be extended almost indefinitely.

Another form of control depends on the truth of the old adage that big fleas have little fleas upon their backs to bite 'em and on the further truth that, very frequently, a large degree of specialization associates particular large fleas with particular little ones. In other words, the pests which attack organisms are themselves the subject of attack by hyper-parasites. It is a form of control commonly termed biological and is well illustrated in the sugar cane by the use of *Trichogramma*, *Lixophaga* and *Metagonistylum* to control the borer. Different in degree only, in

[1] *I.S.J.*, 1941, p. 312.

that it is the little flea that is controlled by the big flea, is the use of the giant toad, *Bufo marinus*.

Of greater importance than all these methods, in that it is applicable to so wide a range of cases, is the growing use of the fact that recent advances in plant breeding have rendered it possible so to mould the host that it no longer dovetails into the parasite. The raising of resistant varieties has become the dominant method of fighting particular fungoid and virus diseases in plants. In the case of the sugar cane, examples are too numerous and too well known to recite here. The resistant variety has been the salvation of the sugar industry of more than one country. Success, however, rests on the high degree of specialization in the host-parasite relationship—a degree such that an alteration in the host may be so slight that the actual difference in such cases escapes identification—and on the fortunate fact that these differences, whatever their nature, are usually of a simple character readily yielding to the art of the breeder.

There is found in Nature, however, a further relationship between two organisms which differs from that of host and parasite. This latter is a detrimental association in that the parasite lives at the expense of the host. The present relationship is a beneficial one for, from it, both gain an advantage. The most striking example of this symbiosis in Nature is provided by the Lichens. This is a true partnership, a particular fungus with a particular alga, in which the association is so intimate that the combination takes on as characteristic a form as that commonly associated with a single species; a form which will reappear even on re-combination of the two organisms after they have been grown in dissociation. In this partnership it is the alga, woven into the hyphal network of the fungus, which builds up the elaborated food supply for their joint use, and the fungus which provides protection, water and the mineral requirements.

Symbiosis plays an important role in agriculture. The best known example is the plant-bacterium relationship in Leguminous plants. The bacterium located within the root nodules characteristic of such plants belongs to a group the members of which are able to "fix" the free nitrogen of the air. Hence the value of a leguminous crop in the rotation, a value which was appreciated by the farmer before the explanation was forthcoming. Of this association it may be said that the specialization is of a high order. On the one hand, it is obligatory, for the legume will not attain its full development in the absence of the bacterium; on the other a free interchange of bacteria between different species of leguminous plants is not possible. For this latter reason it may be necessary, before growing a particular legume where it has not previously been grown, to "seed" the soil with the appropriate bacterium. For this purpose cultures suitable for soy bean and lucerne are now in commercial production.

There is, however, a less known and more general example of symbiosis, recognition of which is likely to have a profound influence on agricultural practice. It is a plant-fungus association in which the relationship is neither that of host and parasite nor partnership, but of landlord and tenant, in which the fungus or mycorrhiza penetrates the tissues of the root. There is accumulating, as the result of recent work, a mass of evidence which, if falling short of final proof, at least strongly suggests that there is here an association which forms an essestial link in the chain of life. Without it, the natural circulation of matter through plant to animal and back to the inorganic state lacks completeness. Plants grown without, or under conditions which lead to an inadequate development of, the mycorrhiza lack stamina, that subtle something which helps them to resist disease. Further, the ill effects of such conditions are not only transferred to the next generation through the seed but become apparent in a diminished value of the product as food for animals, including man. The means by which the mycorrhiza achieves this important result are not yet clear but it may be stated, it is hoped with sufficient accuracy, that it is as an intermediary which short-circuits the full cycle by intercepting the partially decomposed organic residues and serving these direct to the plant. Those residues, humus, thus become an essential factor in sound agricultural practice.

With this conclusion, the problem of soil fertility is at once placed on a new plane. It is no longer sufficient to consider it in its purely physical and chemical aspects, a problem of soil texture in which the role assigned to humus is the simple one of affecting texture, or of amounts of available plant food, particularly nitrogen, phosphorus and potash. Humus undoubtedly plays a far more subtle role, the details of which have yet to be worked out. In a recent paper[1] R. J. BORDEN writes "It is quite apparent from the data presented herein that soil fertility includes something else besides N, P and K. It is our feeling that this "something else" is largely the relationship between the soil organic matter and its rate of decomposition......Its (organic matter) rate of decomposition will be governed largely by the number and kinds of micro-organisms." May not the key which will provide an answer to this questioning be found in the mycorrhiza associated with the cane plant?

H. M. L.

A TRINIDAD CENTENARIAN.—The *Times* recently mentioned the fact that Jabooran, a Moslem woman who went from India in 1840 to work as an indentured labourer on a Trinidad sugar plantation, has died in that island at the age of 130. She left five children, 27 grandchildren and 67 great-grandchildren.

[1] *Hawaiian Planters' Record*, 1941, 45, p. 61

The Cost and Value of Scientific Investigation.

It will be generally admitted that present day agriculture has ceased to be the empirical industry of former times and has now so definite a scientific basis that it requires technical guidance and investigation if it is to maintain its present status and progress. Stated in other words, any country which neglected to provide for this need would soon find the agricultural section of the community placed at a serious disadvantage in relation to its more foreseeing neighbours and competitors. Yet the provision of funds for the purpose offers a problem fraught with perplexity, and this perplexity arises from the fact that the cost of such investigation conforms to no ordinary system of accountancy. While the benefits, in the sum, are undoubted, it is rarely possible to say that this or that particular investigation has been financially profitable. These are the conditions where the small unit cannot undertake the cost, for it cannot afford the risk; and in most countries, the industry is built up of such small units.

That is one aspect of the case but there is another. Agriculture is in all countries a basic industry and in many the dominant industry. It is more than that; it is a mode of life of a large section of the community. Agricultural prosperity materially affects the prosperity of the community as a whole; it may even be said without gross exaggeration that a prosperous agriculture is essential to the health of all communities. There is, thus, a very pertinent argument in favour of the cost of these investigations being in part at least borne by the community as a whole—in other words, that it shall be state-aided. These two arguments have, in most countries, carried the day and agricultural investigations are, for the most part, considered to be a function of government and the cost, thus, centralized. This has two disadvantages; in the first place, though we are told never to look the gift horse in the mouth, it is indubitably true that the mass of humanity has relatively little respect for something it does not pay for and the practical result of this attitude is the difficult problem of how to bring the results of investigations so conducted effectively to the notice of the practising agriculturist. In the second place it means a divorce between theory and practice which encourages the investigator to follow the, to him, more interesting paths of theory.

It would form an interesting commentary on this theme to follow out the way these problems have been answered in the different countries and to trace the degree of success attained in each case. Such a study cannot be undertaken here. No finality, universally accepted, has yet been attained and individual attitudes vary widely. To some, such investigation is as vintage port, to be drunk only with due solemnity in the inner chamber—that is the view of some investigators; to another it is the champagne of life acting as a solvent of all and every care; to a third it is the whisky of modern times, dear and nasty; to a fourth, it is the poison which represents all that is evil. In view of this divergence of opinion on the value of investigations of this nature, it is as well that, from time to time, the community should be reminded of the debt it owes to the investigators. Such a reminder lies before the writer in an article entitled "Research on Sugar Plants and Some Practical Adaptations" by E. W. Brandes and appearing in the *Archief*.[1] The paper is confined to a consideration of the work sponsored by the United States Division of Sugar Plant Investigations during the past 20 years and the conclusion drawn is that its value approaches a thousand million dollars of conserved capital and added national wealth. That is the estimated value of the direct gain; indirectly, half a million persons who might otherwise be on relief have been given a means of livelihood. The cost of this research is not given but it is noted as relatively little.

In this period of 20 years a series of interruptions have marred the smoothness of the path of the several sugar industries due, for the most part, to natural causes, principally disease. The situation in the Southern States, culminating in 1926, was so ominous that the death knell of the industry was confidently sounded. Even the minor poultry industry was claimed to be more profitable. The cause was the unnoticed introduction of the virus disease, mosaic. As is well known, the remedy was found as the result of an elaborate programme involving the combing of the world for breeding material. In 1927, when the first new variety was introduced, the nadir had been reached with the production of under 50,000 tons sugar. The rise has since been continuous as the result of further varietal introductions until, in 1938, production had attained nearly 500,000 tons—a ten-fold increase from approximately a doubled acreage. Puerto Rico has the same story to tell, though with less emphasis for, with its more variable climate, the disease was responsive to an adequate degree of control by rogueing in certain tracts.

In arriving at an estimate of the return from the investigations conducted, all production with released plant material where failure had resulted from low yield and part of the production on lands jeopardized but not actually abandoned is accounted as credit. Further credits are the capital investment in factories, machinery, plantation railways and specialized equipment in areas abandoned or marked for abandonment. On this basis the industries of the Gulf States owe to these investigations over a period of 14 years $350 million with the present employment of 60,000 workers or, calculating three dependents to each worker, a livelihood for 240,000 persons

[1] *Archief*, 1941, 2, pp. 74-84.

The first mosaic resistant variety was supplied to Puerto Rico in 1919 since which date the yield of sugar per acre has increased by over 100 per cent. Though the early investigations here were the work of the Division, they have been carried on by the local institutions, to the work of which further improvements are due. For this reason only half the annual increments in acre-yield are taken in credit, but even so, these total $225 million while salvage of capital investment totals $10 million with livelihood for 25,000 workers or, with their dependents, 100,000 persons.

These are the conclusions drawn in respect to the cane sugar industry. The history of the beet sugar industry runs on parallel lines. In the decade preceding 1934 the average acre yields dropped in some of the Western States from 15 to 5 tons or less, not taking into account the acreage abandoned. This resulted from the ravages of the sugar beet virus disease known as curly top. It is the record of an area newly opened up under reclamation projects with high hopes, a brief period of fine prospects followed by failure and ultimate abandonment with factories, each representing some half million dollars, left derelict. The nadir here was reached in 1929 when work on the disease was commenced. 1931 saw the first evidence of the road to recovery in the development of resistant varieties and, by 1934, the variety US 1 was introduced for cultivation by the farming community. Varieties US 34, US 33 and US 12 followed in quick succession and, by 1939, some 235,000 acres of the 300,000 acres subject to curly top were planted to varieties arising from these investigations. As a direct result the cultivation of sugar beet has been renewed in California, Nevada, Idaho, Utah, New Mexico and western California; dismantled factories have been re-equipped and new factories erected. These, it is stated, are the consequences emerging from the work of a dozen or more scientists.

In this case the capital invested in farm lands, farm equipment, irrigation systems, factory equipment, transportation and power facilities directly concerned in sugar production is placed at $350 million, to which must be added that of the important subsidiary industries of supplies and services and the livestock industry supported on the sugar beet industry's by-products. Nearly one fourth of this capital, say between $80 and $100 million was jeopardized. Credit is reasonably taken, therefore, for the major portion of this as well as of the $25 million representing the recent expansion of the western industry.

If these are what may be termed the direct consequences of these investigations, the indirect consequences are of hardly less importance. For nearly a century the State's beet industry had been dependent on Europe for its seed supply and it required the impetus of the demand for specialized varieties to bring home the precariousness of such a dependence. Methods had to be, and have been through the sponsoring of the Division, worked out for the raising of beet for seed and they differ radically from the conventional European methods. These "garden" methods have been replaced by short occupancy of the land and the abundant use of machines. 1939 saw the production of over 6 million pounds of seed of the resistant varieties and the total of home raised seed, which includes that of leaf-spot resistant varieties, in that year amounted to nearly 14 million pounds.

A brief indication is given of what this means to the industry under the present war conditions by a comparison with what happened during the last war when meagre supplies of seed were obtained from Germany through the blockade under bond prohibiting resale and exacting the return of the sacks. The possibility of unlimited expansion, should the world situation demand it, now exists and it is a security of a national industry the value of which is incapable of monetary expression. The direct benefits in the returns to the farmer in the seed industry amount to some $1·1 million per annum.

These are the results of investigations which have already been capitalized. Much further work* is in progress, not yet but soon likely to be capitalized. Such is the work on cold tolerance of the sugar cane and on black root and leaf spot of the sugar beet. In the first of these, advantage is being taken of the discovery in central Asia in 1936 of cold-resisting wild canes. The difficulties experienced here lie in the very different flowering periods and have been overcome by using the reversed seasons above and below the equator, growing the male parent in the North and the female in the South and transmitting the pollen by air. Thus was the first cross effected. The subsequent back cross was made locally by artificial advancement of the flowering of the commercial cane in a photo-period house.

Black root and leaf spot are two diseases which have caused trouble in the Intermountain and Pacific regions. Seed treatment, rotations which starve the pathogenic organism plus other field sanitation methods have largely controlled the toll taken by the first of these diseases. The latter is being met by the same means as curly top, by resistant varieties, and US 217, released in 1938, has a high degree of resistance with a better performance than the European brands. A new release is US 200 × US 215 in which, besides resistance, advantage is taken of first generation hybrid vigour. Of this only a limited amount of seed, some 200,000 lbs. in 1939, is available.

Such are the results attained in the relatively brief span of activity of the Division. It may be argued that the law of diminishing return will come into play, but it has to be realized that the incidence of any new disease constitutes a new starting point.

H. M. L.

Continuous Operation of Subsiders

Fitted with Feed Wells.

By J. G. DAVIES and R. D. E. YEARWOOD, Imperial College of Tropical Agriculture,
in collaboration with
C. R. D. SHANNON and P. J. KNOX, Ste. Madeleine Sugar Company, Trinidad.

The rapidity of settling observed during the 1940 experiments on intermittent subsiders fitted with centre wells[1] led to the suggestion that a battery of such subsiders might be so arranged that continuous operation would be possible. Until the present experiments were completed, it was not known that intermittent type subsiders had previously been operated in this manner, e.g., according to the patent by CUERVO and GALDO described by MASCARO.[2] Their method is to operate the battery in parallel, after fairly elaborate modifications have been made to the plant. No full description has yet been found of either the necessary equipment or the exact method of operation. It does not, however, appear to include the use of centre wells.[3]

The success of the centre well for continuous operation is based on adequate provision being made for obtaining optimum juice velocities so that the flocs once conducted to the bottom of the tank will remain there. Considering the newer types of continuous subsider, the Fortier is rectangular in horizontal cross-section, while the Dorr, Bach and Graver are each cylindrical. In the Fortier, the result is that the juice flows at even velocity over the trays to the point of draw-off. In the Dorr, Bach and Graver the velocity of the juice either decreases during the course of flow from point of admission to point of draw-off or it increases. At the point of admission to the tray, that is when the juice is mud-laden, there is therefore considerable variation in velocity in the different designs.

The continuous operation of intermittent type subsiders fitted with centre wells is comparable to that of the conventional type continuous settler. The main structural difference is that, while in the latter the compartments are super-imposed, in the former each tank forms a separate compartment. A rectangular tank fitted with centre well and operated continuously has a straight-forward flow at even velocity which is similar to that in the Fortier. Also the centre well conducts the flow downwards in a similar manner to the baffle at the inlet end of the Fortier.

EXPERIMENTAL.

The experiments were conducted in the College Factory. Later, some observations were made on an installation at Usine Ste. Madeleine. In the experiments carried out at the College the juice velocities at discharge from the centre well were 0·33 f.p.m. and 13·8 f.p.m. At Usine Ste. Madeleine, the juice velocity at discharge from the centre well was 0·6 f.p.m., and the velocity along the length of the tank 0·198 f.p.m. Also, in the College experiments, the effect of an oil seal with continuous operation was examined.

(a) *College Experiments.*—When operating the subsiders in the Experimental Factory continuously, the lower juice velocity, 0·33 f.p.m., was obtained by working four subsiders together, each fitted with a 14 in. diam. centre well. The higher velocity of 13·8 f.p.m. was obtained by a similar arrangement except that the centre well diameter was 2·25 in.

The first attempt was made with juice entering at the higher velocity, 13·8 f.p.m. without an oil seal. A state of extreme turbulence was created, and there appeared to be no possibility of obtaining settled juice. This experiment was therefore abandoned.

Clarifiers Nos. 1 and 2 were then fitted with centre wells to give the lower juice velocity, 0·33 f.p.m. Further, Nos. 2 (0·33 f.p.m.) and 3 (13·8 f.p.m.) were oil-sealed, so that the four subsiders then provided means to obtain a strictly comparable test at each velocity with and without oil seal.

Again difficulties were experienced as in the Part II experiments[4] because of the lack of size and the arrangement of the subsiders. The draw-off pipe floats enter the juice immediately next to the centre wells, hence with a 3 in. immersion of the pipe, and centre wells 30 in. deep, the clarified juice had to be drawn off a distance of 27 in. immediately above the point of inlet.

The conditions were therefore by no means favourable for the test, and the required delicacy of control of rates of inflow and outflow of juice and mud was beyond the possibilities of the equipment for any prolonged period. However, a reasonably satisfactory run was eventually obtained. During this time, the higher velocity without oil seal showed no signs whatever of proper settling, but the subsider was nevertheless operated so that the velocities, etc., should not be upset. The other three subsiders gave varying results. They are set out in the following table :

1 *I.S.J.*, 1940, p. 245; 1941, p. 306. 2 *Proc. 11th A.S.T. Cuba* (1937), p. 71.
3 The term "centre well" is here used to continue the original terminology, and give credit to the original Hawaiian work. But neither in the College factory subsiders nor at Ste. Madeleine is the centre well in the centre of the tank. The term "feed-well" would be more appropriate, and is used in the title of this paper. 4 *I.S.J.*, 1941, p. 306.

Juice inlet, velocity f.p.m.	0·33	0·33	13·8	13·8
With or without oil seal	with	without	with	without
Clarified juice : C.S.R. turbidity	0·635	0·774	1·190	—
Mud : Total insoluble matter per cent.......	2·0	1·6	1·6	—

Bearing in mind the size and other features of the equipment and the conditions under which this experiment was carried out, it appears indicative that a low juice inlet velocity with oil seal gives the best results. Also, a low juice inlet velocity without oil seal is of greater value than a high juice inlet velocity with oil seal.

(b) *Ste. Madeleine Observations.*—Prior to the actual carrying out of the College experiments, mention had been made of them to Mr. C. R. D. SHANNON, Chief Engineer of the Ste. Madeleine Co. As a result he and Mr. P. J. KNOX, Chief Chemist, operated their centre well intermittent subsiders continuously with satisfactory results.

are 6 ft. deep, whereas in the other six units the plates are only 4 ft. deep. This difference was with a view to determining whether any advantage would be derived from the deeper centre well. Under the particular operating circumstances none has been observed.

Fig. 1 also indicates that juice enters the centre well through a manually-controlled valve. Clear juice leaves at the opposite end through an anti-scum bend, which is placed just below the scum evel and which is provided with an air break to prevent syphonic action. When liquidating, clear juice is drawn off by way of cocks placed at convenient heights above the mud level.

It should be noted that the mud outlet is at the juice inlet end on the centre line of the bottom plate, and not directly below the centre well.

Mechanical scrapers operating at 5 f.p.m. are provided over the full length of the bottom of the tank, in order to drag the deposited mud towards the mud outlet. The method of operation evolved is as follows :—

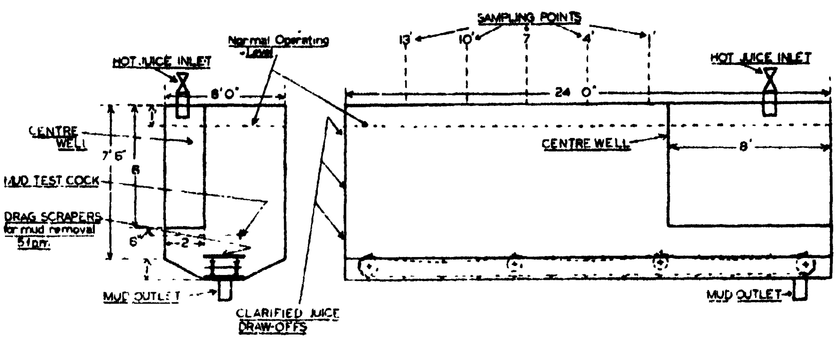


Fig. 1.

The tanks are emptied in rotation, so that there is always one empty, one liquidating, one filling, and the other four in continuous operation. By continuous operation is meant that hot treated juice is continuously entering the centre wells, and clarified juice continuously being decanted. Suitably placed mud test cocks, as shown in Fig. 1, run mud from the first 15 to 20 mins. after filling. Good quality clarified juice can however be decanted from the top draw-off almost as soon as the subsider is full. From that point onwards the mud cocks run clear juice and there is no re-appearance of mud at test cock level. Experience with this particular installation has demonstrated that mud need only be discharged when the subsider is liquidated, as in the cycle described above, which normally is once in every 15 hours.

The clarifier installation at Usine Ste. Madeleine comprises two 18 ft. diam. 5-compartment Dorrs (not Multi-Feed) of 27,000 galls. capacity each, and seven rectangular tanks arranged as a battery, each tank being of 7000 galls. working capacity. The total juice flow varies between 36,000 and 38,000 galls. per hour, of which 16,000 to 18,000 galls. per hour is handled by the battery and 20,000 galls. per hour equally divided between the two Dorrs.

It is to be noted that the installation of the battery of intermittent subsiders in this particular manner was done to meet an emergency, at short notice. It was necessary that floor space should be economised. The tanks were originally 14 in number, installed in line. Each tank measured 6 ft. wide as at present, but was then only 12 ft. long as against the present 24 ft., and only 4 ft. 3 in. deep at the sides as against the present 7 ft. 3 in. Reference to Fig. 1 will show that the centre well is located at the side of one end, the rectangular enclosure measuring 8 ft. long × 2 ft. wide. In No. 1 unit the plates forming the enclosure

The observations were carried out on No. 1 clarifier. At first it was hoped that a "contour map" of the mud levels at varying distances from the centre well would be obtained, so that some idea could be derived of the required dimensions for any future installations. In actual fact, a dip tube extending to a depth of 5 ft. below the surface of the juice failed to reveal any mud as such even close to the centre well. This gave fairly conclusive evidence that even with continuous operation, admittedly at low velocity, the centre well was conducting the flocs to the

bottom of the subsider and once there they failed to rise again in any number.

Observations were therefore made on juice turbidities at increasing distances from the centre well. All samples were drawn off 2 ft. 6 in. below the surface and 3 ft. 6 in. above the mud level test cock. The result of the triplicate tests are presented below.

Distance from centre well ..	1 ft.	4 ft.	7 ft.	10 ft.	13 ft.
Juice: C.S.R. turbidity	0·619	0·471	·0373	0·351	0·342

The mean mixed juice purity for the hourly periods previous to the taking of any one set of observations was 77·16. A composite of the run-off from all intermittent clarifiers operating continuously gave 0·565 C.S.R. turbidity.

Considering the results in the above table, it will be seen that the turbidity decreases fairly rapidly up to 7 ft. from the centre well, after which the rate of decrease is somewhat slower.

Although the nominal working level of the subsiders is 1 ft. from the top, in actual practice and with the temporary nature of the installation, the operators find some difficulty in maintaining a constant level. Varying rates of juice feed and draw-off must lead to disturbances within the body of the subsider. But even so, and with such a low purity mixed juice, the clarified juice is of good quality.

With the method of operation previously described it is seen that there is the equivalent of five subsiders full, if the rate of emptying one is equal to the rate of filling the other. At 16,000 galls. per hour, this allows 2·19 hours as the interval in which the juice passes through the intermittents. At 18,000 galls. per hour, the time is 1·95 hours.

An examination of the reaction of the juice at different distances from the centre well is of interest. The means are set out below.

Distance from centre well ..	1 ft.	4 ft.	7 ft.	10 ft.	13 ft.
pH Draw-off juice	7·08	7·10	7·07	7·02	6·98

It is to be noted that the general tendency is for the *pH* to decrease as the distance from the centre well increases, i.e., as the time in the subsider increases. Each subsider is completely liquidated in rotation every 15 hours. There is therefore little likelihood of juice stagnation taking place. Liquidating in rotation is in fact one of the excellent features of this *modus operandi* as evolved by the Ste. Madeleine staff.

It is known that when tri-calcium phosphate is precipitated in cane juice, the decrease in *pH* value on heating and settling is partly due to hydrolysis with the formation of free phosphoric acid and hydroxyapatite. The decrease in *pH* values recorded above may therefore be due to the residual effects of this reaction taking place.

From the operational point of view, the liquidation of each subsider in rotation is worthy of discussion. Both intermittent subsiders and continuous subsiders have their advantages. The main intermittent subsider advantages are: (i) The station is more flexible, and (ii) there is no possibility of juice or mud stagnation. The advantages of the continuous type are: (i) Low floor space requirement, (ii) low labour operating costs, (iii) denser muds, and (iv) improved heat economy.

In operating intermittent subsiders continuously by the Ste. Madeleine method, flexibility and avoiding stagnation are retained. Substantial saving in floor space is effected, because intermittent subsiders of this depth could only operate on a considerably lengthened cycle. Also, being of such length mechanical scrapers are required to move the mud towards the outlet. Increased length means a proportionate reduction in operating platform space. More important still is that a battery of 2nd subsiders can be dispensed with, and yet provide a suitable mud for the Oliver-Campbell Filters.

As mentioned previously the installation was erected hurriedly, for one crop's operation only. In a permanent arrangement certain changes could be made to facilitate operation, by way of suitable juice inlet and outlet controls and continuous mud withdrawal if required. Such changes would make operation possible with no more than one attendant to the battery, whereas at present two are required.

Similarly, the battery is not lagged. Even so, temperatures of clarified juice compare well with that from the Dorrs, 94°C. as against 96°C. respectively. This is brought about by the compact arrangement of the subsiders.

Conclusions.

For continuous operation of intermittent type subsiders, the following conclusions are drawn from the present work: –

(i) A low juice inlet velocity is beneficial.

(ii) Surface insulation, such as is afforded by an oil seal, is also beneficial.

(iii) With juice discharge velocity from the centre well of about 0·6 f.p.m., and a velocity of juice travel along the clarifier of 0·198 f.p.m., there is little appreciable decrease in turbidity of clarified juice at a distance greater than 7 ft. from the centre well.

(iv) The mud is denser, and hence more suitable for Oliver-Campbell filters than that formerly obtained after the second subsidation in batteries of intermittently operated subsiders without centre wells. In this respect it appears to be similar to that obtained from the Dorrs operating with the same juice.

(v) The simple and effective method of operation evolved by the Ste. Madeleine staff is such that there is little likelihood of juice or mud stagnation.

Selection of Suitable Steam Traps.[1]

For General Sugar Factory Work.

By R. L. GEORGE.

In the opinion of the writer, a very large portion of the trouble with traps has been due to three causes: (1) Cutting down the price to such a low figure that it is impossible for the maker to turn out an efficient and reliable article; (2) the use of an unsuitable design; and (3) insufficient care in the selection of the right type for the application. The first two points are easily disposed of by purchasing, at reasonable prices, from leading manufacturers. This paper endeavours to set out a few notes on the third point.

There are two well-known modern designs of steam trap, viz., (*A*) using a ball float arranged for continuous discharge, and (*B*) an inverted bucket arrangement for intermittent discharge. It is difficult to generalize on which type should be used for any particular application. The ball float type is recommended: Where the continuous discharge of condensate is preferred; for all superheated steam mains; for all general drainage purposes where a closed system is employed; and for all very low pressures. If there is likely to be air in the system, an air by-pass is fitted.

The inverted bucket trap is recommended: (*a*) Where an intermittent discharge of condensate is preferred; (*b*) for general drainage purposes where open systems are used with a considerable quantity of air in the piping when going into service; (*c*) for general process work, heating coils, steam heating systems, calorifiers, etc.; and (*d*) for all drainage systems in which air is liable to be entrapped, owing to the unsatisfactory layout of the pipe system.

For general sugar factory work the inverted bucket trap is recommended for high pressures, say 100 to 200 lb. per sq. in., and the ball float type for exhaust pressures, say up to 25 lb. per sq. in. It has unfortunately been the practice to purchase traps by specifying merely the size, but if they are to function properly they must be bought on the basis of capacity. That two traps are of the same nominal size does not by any means indicate that they have the same capacity, as one may have a capacity several times that of the other.

In designing steam traps, the body must be made suitable for the maximum working pressure of that portion of the system on which it will be installed. The working parts, however, should then be designed to give the maximum capacity under the actual working pressures across the trap. For instance, a 1 in. trap to operate with a pressure difference of 100 lb. per sq. in. will have entirely different working parts from a 1 in. trap to work with a pressure difference of only 25 lbs. per sq. in., even though the overall sizes may be identical.

Steam traps are made of various standard sizes, and are classified according to the working pressures for which they are designed. They may be designated A, B, and C, and for a 1 in. trap the pressure ranges are Class A, 0 to 50; Class B, 51 to 100, and Class C, 101 to 200 lbs. per sq. in. The bore of the seat is largest in Class A and is slightly reduced for each higher range of pressure. This is necessary in order that the load on the seat may not exceed the safe operating power of each particular size of trap. The largest capacity of each seat is obtained when the trap is working at the highest pressure permissible and, therefore, the greatest capacity is obtained at the pressures of 50 lbs. for Class A, 100 lbs. for Class B and 200 lbs. for Class C traps respectively.

The table gives the approximate capacities of modern inverted bucket traps and also ball float steam traps, when discharging continuously with pressure differences as stated in the table. By pressure difference is meant the actual pressure acting across the trap itself, so that in cases where the trap discharges against a positive pressure, this must be subtracted from the inlet pressure to give the true pressure difference. The capacities stated are for continuous discharge and therefore a maximum, and some margin should be allowed for intermittent working of the trap and losses due to pipe friction. It will be noted that the smallest capacity occurs at the low pressure section of each class, so that the capacity at 50 lbs. is greater than that at 60 lbs. or alternatively, a 1 in. trap at 50 lbs. has almost the same capacity as a 1½ in. trap at 60 lbs. The same applies to other sizes and comparative pressures.

	Pressure Difference. Lbs. per sq. in.	Bore of trap in inches. ½	¾	1	1½	2
		Maximum galls. per hour.				
Class A—	20	90	180	360	720	1440
Up to 50 lbs.	30	110	220	440	880	1760
	40	125	250	500	1000	2000
	50	140	280	560	1120	2240
Class B—	60	75	150	300	600	1200
51 to 100 lbs.	80	87	175	350	700	1400
	100	96	192	385	770	1540
Class C—	125	54	107	215	430	860
101 to 200 lbs.	150	59	117	235	470	940
	175	63	125	250	500	1000
	200	66	132	265	530	1060
Cast steel—	250		72	144	288	575
201 to 350 lbs.	300		79	158	315	630
	350		85	170	340	680

[1] *Proc. Queensland Soc. Sugar Cane Tech.*, 12*th Conf.*, pp. 181-186.

Traps are very often supplied according to the pressure stated on the order, which is probably the maximum pressure or the nominal pipe line pressure, given to ensure that the trap will be strong enough to withstand the highest pressure. It is, however, equally important to know the pressure difference under which the trap will generally require to operate.

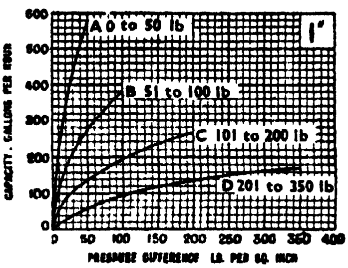


Fig. 1

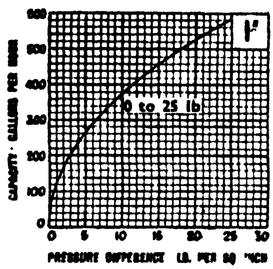


Fig. 2.

and this is often less than the maximum on account of long lengths of piping and the attachment of comparatively small drain pipes to the trap. For instance, a trap may be ordered for 60 lbs. pressure, in which case a Class B trap will be supplied. However, it is quite possible that the actual working pressure at the trap is in the region of say 40 or 50 lbs., in which case a Class A trap would be preferable, particularly where a large capacity is required. On the other hand, modern traps allow a little margin of pressure, and in cases where the maximum pressure of a particular installation exceeds the limit of Class A by say 10 lbs. or Class B or C by 20 lbs., the makers would, in cases of emergency, concede this amount of excess pressure, which would probably reach the trap only at infrequent intervals.

As an example of this point, we would mention a recent enquiry which specified a certain capacity to be discharged at 60 lbs. pressure. This normally would have required a 2 in. Class B trap, but if the 10 lbs. excess pressure were allowed, a $1\frac{1}{2}$ in. Class A trap would have given the same capacity as the 2 in. trap, both working at 60 lbs. pressure. It is, of course, very difficult for the user to know when this latitude can be taken, and it is necessary to consult the maker in order to be on the safe side. Fig. 1 gives a range of curves for 1 in. traps designed for four different pressure ranges, namely 0 to 50 lbs., 51 to 100 lbs., 101 to 200 lbs., and 201 to 350 lbs. per sq. in. Fig. 2 gives the curve for a special low pressure 1 in. trap designed for a maximum pressure of 25 lbs. per sq. in.

In all cases, pressures quoted on the curves are pressure differences across the trap. The design principles apply to all makes of trap, and no maker can possibly give full service to the user unless he provides a series of traps, each for a particular pressure range. It will be clear from the table and from these curves that if a 1 in. trap is ordered, without its being clearly specified on what range of pressure it is to work, the user may obtain a trap with a very much lower capacity than that available by correct selection.

One could, for instance, buy a 1 in. trap suitable for a pressure range from 201 to 350 lbs. per sq. in.. and use it on an exhaust main with a pressure difference of 10 lbs. per sq. in. The capacity under these conditions would be roughly 10 galls. per hour (Fig. 1, Graph D), whereas the correct 1 in. trap, designed for a maximum pressure of 25 lbs. per sq. in. would have a capacity of 380 galls. per hour under the same conditions (Fig. 2). The prices of the two traps would be about equal, but the one used in its correct pressure range would have a capacity 38 times that of the other.

A proper understanding of the principles of trap operation and design enables the user to select the right trap for every application and thus ensure for himself many years of trouble-free service.

New B. & L. Refractometer.—What are claimed to be outstanding advantages in favour of the latest design of the B. & L. refractometer comprise: (1) compensator errors are avoided by the use of a sodium vapour light; (2) the total error is diminished by a large, long taper bearing; (3) the full scale is used for the range from 1·33 to 1·50, readings made to 0·00003; (4) there is a quick temperature equilibrium due to the small quantity of liquid required; and (5) there is a minimum of moving parts, all of which are easily cleaned.

Kanex Bagasse Plastic.—It is announced that a new plastic called Kanex has been developed by Valentine Sugars, Inc., Lockport, Louisiana, by the treatment of bagasse with certain chemicals, the identity of which has not yet been disclosed. It is a satisfactory non-conductor of electricity, is very strong, and is said to be capable of manufacture at a price below that of any other plastic on the market. Credit for evolving it is given to T. R. McElhinney, chief chemist to Valentine Sugars, Inc. A factory for its production is being built at Lockport.

Motor Spirit from Molasses.—As we go to press, some particulars come to hand of an invention which may have a considerable effect in solving the problem of the production of fuel alcohol from waste molasses in certain sugar-cane growing countries. Briefly it consists in fermenting the sugars present in molasses to butyl alcohol, which is then "polymerized into a chemical equivalent of gasoline with a high octane content." Dr. J. W. Jeans, of Pasadena, Calif., is the inventor of the polymerization operation, and the process as a whole is sponsored by Dr. Wm. L. Owen, of Baton Rouge, who has patent rights on certain of its aspects. At a recent demonstration of a pilot plant made at Baton Rouge, Dr. Owen stated that the "sugar gasoline" would cost about 15 cents per gallon to produce, i.e., three times the cost of the natural product, so that manufacture would be economically impracticable except in countries having surplus molasses and high-priced imported petrol.

The Future of Mill Electrification.[1]

By M. K. CARTER, of Kalamia S.F., Queensland.

It is hard to understand why the electric motor is not used in Queensland for the most important duty in a sugar factory, viz., the crushing mills. Many other industries use heavy electric drives, cement, e.g., on such units as ball-mills, slurry-kilns. A well known steel plant in Australia employs heavy electric drives.

There are many advantages for full electrification.[2] On the other hand, there are a thousand reasons from the "established practice" point of view why motors should not be used to drive crushing mills, and it will be necessary before planning a complete electrically operated factory, to have a mild engineering revolution. The following suggestions are made regarding the conversion of mills to electric drive.

The ideal position for the power-house would be beside the boiler-house. This has the advantage of making possible short lengths of steam main from the boiler-house, and a short cable to the mill motors. The next step is the selection of the type of prime mover and generator to be used. A single stage impulse turbine of the, back-pressure type offers economy of space, absence of oil in steam, freedom from excessive vibration, uniform angular velocity, large overload capacity and high efficiency over a long range of load. As regards the generator, the high efficiency of the alternator is well known, and alternating current drives only will be considered in this paper.

A 6600 volt alternator is preferred to the usual 415 volt type for the reason that less space is required per kVA and a saving is effected in copper and size of switchgear. The insulation of the total installation must necessarily be of a higher standard, but the reduced size of the switch contacts and main cables easily offsets the extra care required in carrying out the installation. In quite a number of industrial plants employing electric drive, medium pressure voltage (6600 volts) is found much more flexible where heavy drives are concerned.

Power Plant Capacity.—As from a certain quantity of bagasse only a certain amount of boiler steam will be available, it is obvious, for example, that for an existing factory the total steam demand for the prime movers after electrification must not be more than that ruling before the change over. When steam conditions cannot be improved, the thermo-dynamic efficiency of the power-house prime movers must be higher than the average thermo-dynamic efficiency of the factory prime movers which are to be replaced by electric drive.

It is recommended (and it has been done in quite a number of instances), that when electrification is considered, on replacement of old boilers, new ones designed for higher steam pressure should be installed. For crushing cane about 100 b.h.p. is required per ton of fibre crushed per hour. The actual power-house capacity varies from mill to mill, and the following examples are given :—

At "Grays Inn," Jamaica, a totally electrified mill is operating[3] a 10,000 ton plant. The dimensions of the mills are as follows : Rollers, 30 in. × 60 in. ; and number of rollers, 14. The capacity of the power-house is 1500 kW, made up of three 500 kW units, two in use and one standby.

"Ingenio Ledesma," Argentina, is another totally electrified mill.[4] The capacity of the plant is 7500 metric tons of cane per day, the milling equipment comprising two tandems of 19 rollers each. One is a "Fives-Lille Trapick" completely electrified and comprising five three-roller mills and a double crusher, with rollers 42 in. × 84 in. Each unit is driven through triple reduction gearing by its own individual motor, 3 phase, 50 cycles, 485 r.p.m. Variation in speed is obtained by alteration of frequency. Power for the milling tandem is provided by a turbo-alternator of 3500 kW with three speeds, 40, 50, 60 cycles. It is usually considered good practice to have at least two units, each of half the required output, and a third of the same size as standby, or for future capacity increase.

The steam turbine as well as the back-pressure or pass-out steam engine has its proper field of application according to size. Below 250 to 400 kVA steam engines of suitable design are usually preferred, whereas above 400 kVA steam turbines generally should be provided. Some people consider the lowest power limit of an efficient steam turbine to be around 1000 h.p. or 750 kVA.

No hard-and-fast rule seems possible for determining the power required for total electrification. but the following figures have been collected as an average value, from records of known totally electrified sugar mills : For a 70-ton per hour crushing rate with each mill consisting of three rollers, dimension of rollers being 3 ft. by 7 ft., the power required by each mill to take all emergency peaks would be 350 h.p.

In the first example given, four mills would require a total of 1400 h.p. or approximately 1050 kVA. The auxiliary plant required, such as pumps, boiler fans, centrifugals, cane unloader, etc., would consume a further 1500 kVA. Therefore it would be necessary to provide in the power-house three 1500 kVA turbo-alternators, two in use, one standby, as well as a 200 kVA oil engine for slack season operation. The

[1] *Proc. Queensland Soc. Sugar Cane Tech.*, *12th Conf.*, pp. 141-146 (here abridged).
[2] Advantages and disadvantages of electrification, partial or total, have recently been discussed. See *I.S.J.*, 1940, pp. 167, 202, 241, 277.
[3] *I.S.J.*, 1940, pp. 167, 202. [4] *I.S.J.*, 1938, p. 214 ; 1940, p. 16.

circuits could be arranged so that all motors except crushing mill drives operated at 415 volts ; a 6600 to 415 volt step-down transformer of 1500 kVA capacity would be necessary. The mill motors would be fed directly from the high tension board.

The type of motor suggested for crushing drives is the A.C. salient pole synchronous type, the most robust, reliable and highly efficient, as well as the lightest for its output, of all types of A.C. motor. It is suggested that the motors be connected through a fluid flywheel to the usual milling gears, the motors to run at constant speed and all speed adjustments to be made by the fluid flywheel.

Fluid Coupling.—The type of fluid flywheel to be used is the variable filling type, known as the scoop-controlled fluid coupling. This type is most commonly used where any speed variation is required. The working principle is as follows :—The quantity of fluid in the working chamber is controlled by means of a rocking scoop tube which maintains a constant circulation through an external circuit of fluid drawn from the working chamber, to increase or reduce the speed of the drive shaft as required.

The fluid is forced by centrifugal action through a number of leak-off nozzles near the periphery into an outer casing rotating with the impeller, this casing being large enough to receive the full contents of the working circuit. The scoop tube is carried in the stationary housing and its open end can be moved progressively from the point where it is out of contact with the annulus of fluid, and the working circuit is empty, to the fully engaged position where the whole of the fluid is transferred from the outer casing and the working circuit is full. Return of the fluid from the scoop tube to the working circuit takes place automatically, adjustment of the scoop tube being effected either directly by hand or by means of a small worm-geared servo-motor when remote control is desired, the servo-motor only running when a change of speed is being effected. The position of the scoop tube determines the amount of fluid in the working circuit and consequently the speed of the driven shaft.

The outstanding features of the fluid coupling are briefly as follows : (1) Ability to "inch" and rotate at very low speeds ; (2) high torque at low speeds ; (3) perfectly smooth acceleration at constant or variable rate ; (4) complete positive and simple control in either direction ; (5) steady speed under fluctuating loads ; (6) protection to installation from damage due to overloads.

The loss in power through the coupling is given by the following example : In a large pumping installation an 883 h.p. motor was connected through a fluid coupling to a centrifugal pump. The effective h.p. at the pump was measured at 856, giving a loss of 27 h.p. through the coupling.

The fluid coupling is now becoming the recognised device for transmitting power in such units as boiler feed pumps and fans.[1] It is used extensively on tin dredges in Malaya, in which variable speed for the top tumbler at the ladder hoist is made possible by the use of a fluid coupling driven by a 400 h.p. motor.

Control Gear for Motors.—The starting gear for the mill motors should be placed on a platform away from unsuitable conditions, and can be of much the same design as that of all modern power plants, i.e., H.T. iron-clad totally-enclosed rack-out cubicles. Automatic gear is not recommended with mill motors, as this would introduce unnecessary complications. Remote control for speed regulation can, of course, quite easily be carried out with electrically-operated servo-motors at each fluid coupling.

The reversal of motors can be carried out in the normal way by interchanging two phases, the interchange being made by means of air break contractors, which would be of very robust construction. The contractors are electro-mechanically operated from the control board of each milling motor. The initial movement of each when closing is done by a solenoid with follow-up mechanical gear manually operated from the same lever which controls the solenoids.

When a contractor is fully closed, the solenoid circuit is interrupted and the contractor held closed by means of a cam. When it is opened the cam pulls the contacts apart and thus positively breaks the circuit. The reversing contactors are so interlocked with other contactors provided in each starting panel that they can only be operated on a dead circuit, i.e., when the main line contactor is opened. Once the mills were under way complete supervision could be maintained from one point on the milling platform. The speed of each mill could be altered by remote control with a saving in labour, and unnecessary rush and bustle could be avoided.

The author is aware that under prevailing conditions the considerations put forward are unlikely to be of much immediate practical value, but hopes that there may be some points of future interest.

Wartime Freights.—As an instance of high freights for sugar during wartime, we may cite the case reported from Java of £15 per ton being paid for shipments last summer from Soerabaia to Suez.

Brazilian Coffee Destruction.—Figures given by the U.S. Department of Commerce covering the Brazilian coffee industry show that the coffee destruction policy inaugurated in that country in 1931 to get rid of the excess of coffee produced has, in the subsequent ten years, eliminated no less than 70,309,181 bags of 60 kgs., that is 4,218,551 metric tons. The largest annual destruction was in 1937 when 1,031,786 tons was disposed of. The Brazilian coffee crop of 1940-41 is put at 1,251,000 metric tons, but that of 1941-42 is estimated to be considerably less, owing to adverse weather conditions during the growing period.

[1] Of more direct interest to the sugar industry is its application to centrifugal drive. Two British centrifugal manufacturers have, within the last two years, adopted the device for their latest designs of centrifugal. See *I.S.J.*, 1939, pp. 221-226 ; 1941, p. 214.—Ed. *I.S.J.*

Sugar Cane Fibre.

By G. C. DYMOND, Darnall, Natal, South Africa.

Fibre is the general term given to a multiple variable in an industry where constants are few.

In bygone days in Natal, Uba cane constituted 100 per cent. of the raw material and its fibre varied within the possibilities of a single variety. To-day, with five varieties constituting the supply, an additional variable has become significant, namely Varietal Quality.

This physical variation of fibre is especially noticeable between two Indian canes: Co 281 and Co 290. The effect of this quality factor is to upset the old fashioned ideas that higher fibre must necessarily indicate lower extractions. In Natal the converse is generally the rule. PRINSEN GEERLIGS forecast this condition in milling practice, when he stated that "In chemical composition the fibres of the different cane varieties do not show considerable differences, but their physical aspects do, thus the fibre of every variety of cane has its own power to resist pressure."

In considering this important factor in practical milling, it appears strange that fibre is always referred to and not bagasse. The numerous definitions of fibre used in the various sugar countries were summed up by Dr. ZERBAN at the Puerto Rico Congress of the International Society of Sugar Cane Technologists, and the following definition was adopted: "Fibre is the dry water-insoluble matter in the raw material delivered to the factory, including clean cane, field trash, etc."

This would appear to be a clear cut definition, but actually the determination of fibre as "water-insoluble matter" is purely arbitrary, since the solubility of fibre in water is affected by temperature, time of contact and nature of fibre.

So-called fibre consists of cellulose, lignin and a pentosan, which vary in proportion according to the variety and its age. In 1930 the author found that the determination of fibre in Uba cane, using boiling water with changes every hour for a period of six hours, gave results much lower than those found by the indirect method recommended by GEERLIGS,[1] the average results being :—

Fibre by Lixiviation.	Indirect Method.	Difference.
12·12	13·42	1·3

The method was thereupon modified, hot water at approximately 80°C. being used and changed every half hour with five changes altogether, the results from 103 analyses being respectively :—

14·58	15·32	0·74

This solubility of fibre in hot water was confirmed in the following manner: A large sample of cane showed 12·7 per cent. fibre by the indirect method, and the following on successive treatments with boiling water :—

1 hour by boiling water	12·87 per cent. Fibre
2 hours ,, ,,	12·15 ,, ,,
3 ,, ,, ,,	11·77 ,, ,,
4 ,, ,, ,,	11·88 ,, ,,
5 ,, ,, ,,	11·82 ,, ,,
6 ,, ,, ,,	11·82 ,, ,,
7 ,, ,, ,,	11·60 ,, ,,
8 ,, ,, ,,	11·33 ,, ,,
9 ,, ,, ,,	11·22 ,, ,,

One would expect small irregularities to be due to experimental errors in sampling. Finally, the errors involved in determining the fibre by lixiviation were further complicated by the discovery that the difference between the lixiviation fibre and that calculated by the indirect method increased with the fibre content of the cane. Thus :—

Fibre Range per cent.	No. of Samples.	Fibre per cent. by Lixiviation.	Fibre per cent. Indirect Method.	Difference.	Moisture per cent. Bagasse.	Difference between Crusher and Residual Juice Purity.
12 to 13	12	12·07	12·53	0·46	63·7	2·3
13 ,, 14	13	12·91	13·47	0·56	63·0	2·8
14 ,, 15	22	14·03	14·57	0·54	61·1	3·4
15 ,, 16	31	14·73	15·43	0·70	63·0	3·5
16 ,, 17	7	15·47	16·43	0·96	59·6	4·2
17 ,, 18	11	16·56	17·53	0·97	59·3	6·0
18 ,, 20	Nil	—	—	—	—	—
20 ,, 21	7	18·60	20·43	1·83	56·8	6·3

In 1941 Mr. BECHARD[2] demonstrated by statistical analysis that the primary juice lost per unit of fibre in Natal decreased as the fibre increased. A preliminary survey of certain mill's work this season shows that in a large number of cases, when Co 290 and Co 281 were crushed over a calculable period, the loss of sucrose in bagasse in the former lower-fibred cane was approximately 0·4 per cent. higher than in the relatively higher-fibred and higher-sucrosed cane Co 281.

This is caused by the difference in the physical quality of the bagasse in these varieties; for, whereas the fibre in the bagasse of Co 290 powders easily, that in Co 281 is long and tough and mills easily.

This new factor of Varietal Quality entirely upsets the effect of the quantity of fibre in relation to extraction and therefore invalidates the principle of NOËL DEERR's reduced extraction formula.

1 "Cane Sugar and its Manufacture." Second Edition. P. 52.

2 Proc. 15th Congress S.A. Sugar Technologists' Association, 1941.

Recent Research on Rum Manufacture.

By RAFAEL ARROYO.[1]

SYMBIOTIC PHENOMENA

Work conducted by the author and his associates in elucidating certain phenomena in the symbiotic fermentation of yeast and bacteria has led to the discovery of an important factor in rum manufacture. It was found that the bacteria had the power of inducing a high rate of multiplication of the yeast cells with which they grew. Also, the enzymal activities of the yeast cells were greatly activated, resulting in a more rapid conversion of the sugars with subsequent appearance of the metabolic products of yeast fermentation.

In certain cases morphological changes were observed, resulting in a striking swelling of the cells, giving them the appearance of so-called giant cells. Besides the youthful cycle of the yeast cells during fermentation was prolonged. But the most striking observation made in these studies was the fact that this stimulus acted best and with increased vigour when the two cultures were separated from each other by a quartz wall.

This increased effect is explained on the grounds that since the metabolic products (especially the butyric acid) of the bacteria are not in actual contact with the yeast cells they cannot exert their inhibitory influences on yeast growth and propagation. Hence, the beneficial effect meets with no contravening factors on its action upon the yeast cells.

VARIATIONS IN FERMENTATION TECHNIQUE.

Much work was devoted during the last fiscal year in studying the modifications in the chemical composition as well as organoleptic character of rum types through the introduction of innovations or changes in either mashing or fermentation operations. The results obtained gave us the general impression that here lies a vast field of endeavour in scientific rum making. Rums manufactured from sugar cane juice were given different treatments either during mashing or fermentation with the following results :—

(a) Rums resulting from the fermentation of raw fresh juice as obtained directly after milling, were faulty as to yields, bouquet and aging qualities. The time taken for acquiring maturity and mellowness was too long, and even then the quality was not of the first order.

(b) Rums made from raw cane juice pasteurized at 80°C. for 10 mins. previous to mashing operations and final fermentation were of much better quality than those from untreated cane juice ; they aged far more rapidly ; and besides, their yields were from 8 to 10 per cent. greater.

(c) Rums produced from juice defecated and clarified previous to mashing and fermentation were of still higher quality as to taste and bouquet. Besides, their maturing properties were fully developed in a comparatively short aging period. Yields were about the same as in case (b) above.

(d) Rums fermented at constant or nearly constant *pH* value during the entire fermenting period offered a raw product of great cleanliness of aroma ; the aroma itself being of a very smooth and delicate nature. The product aged very fast and the mature rum had mellowness, smoothness and delicacy of taste.

(e) Symbiotic fermentations between yeast and certain *fungi imperfecti* gave rise to a really new type of rum quite different to any of the well-known types in the market. Highest yields were obtained.

An effort was made to obtain a molasses rum possessing the characteristics of sugar cane juice rum. Here again, we met with quite successful results, although at the expense of yield. More work is considered necessary along this line.

AN AMERICAN BROKING PIONEER.—By the death recently of Mr. Ariel Meinrath, head of the Meinrath Brokerage Co. of Chicago, in his 83rd year, the United States loses a leading figure in the wholesale grocery brokerage business. His organization was prominently identified with the sale of refined sugar as representing a number of the larger processors, and he attained national prominence because of his experience in the sale and distribution of sugar.

PUERTO RICAN SUGAR CROP, 1940-41.—According to the figures of the Sugar Producers' Association of Puerto Rico, the island sugar crop for the 1940-41 season produced, from the 40 factories at work, 7,745,421 short tons of cane, 931,997 short tons (832,140 long tons) of sugar, with an average tons cane per ton of sugar of 8·311 and a yield of 12·03. The largest individual factory outputs of sugar were Guanica with 80,103 short tons and Aguirre with 73,622 tons.

U.K. SUGAR RATION.—It was announced last month by the Ministry of Food that from November 17th onwards there would be in this country a temporary increase in the ration of sugar from 8 oz. per week to 12 oz., to operate during the mid-winter months. The allowances to catering establishments were to remain unaltered.

BRITISH GUIANA SUGAR CROP FOR 1940.—The sugar crop for 1940 in British Guiana, according to the Director of Agriculture, amounted to 167,645 tons, a decrease as compared with 1939 of 21,600 tons. Cane was reaped from 63,692 acres, 1,348 acres being farmers' canes and the rest sugar estates acreage. The general average yield of sugar per acre was 2·63 tons. Of the total area planted to cane, 37,506 acres were under POJ 2878, 24,162 acres under D 10, and 1,804 acres under D 625. Rum was produced to the amount of 2,084,315 proof gallons, as compared with 1,422,571 gallons in 1939.

1 Extracted from the *Annual Report for 1938-39 of the Agricultural Experiment Station of the University of Puerto Rico.*

Beet Factory Technical Notes.

Factory Waste-water Disposal. A. M. BERLIN. *Sugar*, 1941, **36**, No. 7, pp. 22-23.

At the Clarksburg (Cal.) factory of the American Crystal Sugar Co. a waste-water disposal system had to be installed to control the spread of *Sclerotium rolfsii*, a fungus disease, found in the soil, and attacking the underground portion of the root. Small white fruiting bodies or sclerotia develop on the beet surface as decay progresses, and are capable of floating from one place to another, and thus propagate the fungus. It is essential that factory waste-water should be carefully cleaned of fungoid spores before being returned to the Sacramento River; otherwise water used from the river for irrigation might infect farms previously free of the disease.

It consists essentially of a 5-acre, diamond-shaped settling pond with baffling and screening arrangements. The influent consisting of all factory waste-water, except a portion of the condenser waters, enters at one end through an 18 in. pipe, its flow being distributed by a series of V-shaped baffles and spread out to a width of 400 ft. and a depth of 1 ft. With this great flow area, velocity is reduced to such an extent that all debris which will not float is settled to the bottom of the pond, after which the water proceeds under two sets of surface baffles placed in pairs across and near to the centre of the pond.

These baffles extend 4 in. down into the water and act as a barrier to all floating vegetable matter. After the baffles is a weir extending 6 in. up from the bottom of the pond for the purpose of retaining all vegetable matter which would tend to creep along the bottom. Three longitudinal baffles are then used to converge the water to the outlet end of the pond.

As most of the sclerotia either sink or float, the baffling system described above arrests the bulk of them. However, some of the same density approximately as water can be carried through to the outlet. They are, however, stopped from passing out of the pond by a screening arrangement used at the outlet box, which is 30 ft. wide × about 12 ft. long, in which the water stands about 2 ft. deep. Across the centre of the box are four vertical screens of 11-mesh brass, which are designed to keep debris out of the final screens.

Leaving the outlet box, the water flows through six gates, each 8 in. deep and about 20 in. wide, each of these feeding a screen box having a double screen bottom. The top screen is 20-mesh brass, and the bottom one 32-mesh, these screens successfully screening out any sclerotia in the water flowing through them. They are removable for cleaning. Having passed through these, the water is deemed suitable for pumping into the Sacramento River.

It is advisable to apply some chemical treatment to the water entering the pond. Thus about 0·25 p.p.m. of cupric sulphate is added to arrest the growth of algae, and about 10 p.p.m. of stove top distillate to prevent the breeding of mosquitoes. Also, a little waste lime mud is added during the hot weather to avoid acidity, and some disinfectant or deodorant besides. This settling pond has been operated at intervals under the supervision of plant pathologists of the California State Department who found the water passing out of it to be free of all solid matter (including sclerotia). It has performed its purpose and operated successfully for five seasons.

Water-Soluble Substances in the Beet Seed Ball. BION TOLMAN and MYRON STOUT.[1] *Journal of Agricultural Research*, 1941, **61**, No. 11, pp. 817-829.—The amount of water-soluble substances present in beet seed balls varied not only with variety but also within seed lots of the same variety grown in different years or localities, and is possibly affected by climate, soil and maturity of the seed when harvested. Such substances were found to produce a toxic effect on germinating beet seed, both retarding germination and killing the radicles. This effect may be a very important factor in causing differences in ra'e and total germination of seed lots in seed laboratories. Their adequate removal seems to be advisable in laboratory procedure where blotters or similar substrata are being used for germination tests. They can be removed by either soaking or washing in running water, a 6-hour period of treatment being sufficient for their disappearance. Soaking in a sufficient volume of water to insure dilution of toxic substances was definitely beneficial, but not so effective as washing in running water.

Sizes of Sugar Crystals (in the Sugars made by the Great Western Sugar Co.). *The Sugar Press*, 1941, **25**, pp. 10-13.—Micro-photographs are given illustrating the shape of the crystal of pure sucrose, and showing the relative sizes of the crystals composing: Table fine granulated; "sanding sugar"; bakers' granulated; XXX-XXX powdered; and Johnstown granulated. Sanding sugar is coarser than fine granulated, and bakers' granulated is really an icing sugar. Johnstown granulated is pure sugar extracted by a modification of the Steffen process from the final beet molasses sent in by all the G.W.S. Co. beet factories to the Johnstown plant. Such molasses contains 3 to 6 per cent. of raffinose, and though the Johnstown sugar contains 99·9 per cent. sucrose its crystals no longer possess the typical sucrose form. They are much more elongated (as is shown in a micro-photograph in original). Its habit of crystal growth is said to have been modified by its association with the raffinose crystal, though it contains the trisaccharide only in undeterminable traces.

[1] Bureau of Plant Industry, U.S. Department of Agriculture.

Chemical Reports and Laboratory Methods.

Determination of Reducing Sugars by the Munson and Walker Method: Errors of their Tables. RICHARD F. JACKSON and EMMA J. McDONALD.[1] *Journal of the A.O.A.C.*, 1941, **24**, pp. 767-788.

Gravimetric methods for the determination of reducing sugars have the disadvantage of being more time-consuming than volumetric processes, but when modified by the introduction of volumetric methods for the determination of the reduced copper they approach the volumetric methods with respect to convenience and rapidity. In the U.S.A. the Munson and Walker gravimetric method[2] is still extensively used at the present time. It has the advantages of extreme simplicity and high precision.

ERB and ZERBAN[3] have re-determined the copper values of the M. & W. method for sucrose-invert mixtures containing 0·4 grm. of total sugar, their results being in agreement with those of M. & W. for the middle range of concentrations, but in disagreement at the higher ones. HAMMOND[4] recently made a comprehensive revision of the M. & W. tables. Many of his values differ from those of M. & W. by amounts far greater than any probable experimental error. It was the purpose of the present authors to contribute a third series of tables, and to ascertain the source of the discrepancies between M. & W.'s and Hammond's copper values.

They find these differences to be due almost entirely to the respective methods of estimating the copper. M. & W. weighed the Cu_2O, but it is now known that the precipitated Cu_2O may be contaminated with organic decomposition products even when pure sugars are being analysed. On the other hand, HAMMOND determined the reduced copper by electrolysis.

The present authors also show that Hammond's tables should be substituted for those of M. & W. formerly used. Erb and Zerban's analyses of 0.4 grm. of sucrose-invert sugar mixtures are in agreement with those of HAMMOND except within a short range of lower concentrations. The present authors' figures here presented are in agreement within this range.

Further, the present investigation shows that reduced copper should always be determined by analysis, and not by the direct weighing of Cu_2O. Various methods for the determination of this copper are discussed. During the investigation the main reliance was the iodometric method in acetic acid with the concentration of KI (4·2 grms. per 100 ml.) specified by SHAFFER and HARTMANN,[5] and with the addition of thiocynate at the end of the titration, as specified by FOOTE and VANCE.[6] Accurate results were obtained by the permanganate method, as modified by SCHOORL and REGENBOGEN.[7] A method of determining Cu_2O by oxidation with an excess of dichromate and back-titration with ferrous sulphate to a colorimetric or electrometric end-point is described in this paper.

Sucrose. grms.	Invert Sugar. mgrms.	By Thiosulphate. mgrms.	By Electrolysis. mgrms.	From HAMMOND'S Table. mgrms.	From ERB and ZERBAN'S Formula. mgrms.	By Dichromate. Colorimetric. mgrms.	By Dichromate. Electrometric. mgrms.
1·880	120	—	238·9	238·7	—	238·8	238·6
1·793	207	385·6	384·7	384·2	—	—	—
1·770	230	421·6	421·2	420·3	—	—	—
0·340	60	156·4	—	156·5	158·2	156·9	156·8
0·320	80	119·6	—	119·7	121·3	—	—

In the adjoining table are given the weights of copper obtained from various sucrose-invert sugar mixtures. These values follow the general tendency found in the previous analyses: an agreement with HAMMOND at the middle range of concentrations, and a slightly greater recovery of copper at the high ones. In the analyses of 0·4 grm. of total sugar the results obtained by the writers are in practically perfect agreement with those of HAMMOND.

As for the precision of the M. & W. method as indicated by Hammond's and the present writers' independent analyses, this is shown to be about 0·2 per cent. If the concentrations of sugar are restricted to the range between 69 and 207 mgrms. of reducing sugar, the average precision appears to be about 0·1 per cent.

Determination of Unfermented Reducing Substances in Molasses. F. W. ZERBAN.[8] *Journal of the A.O.A.C.*, 1941, **24**, pp. 656-662.

Of the several methods proposed for this determination, the Associate Referee decided to study collaboratively that of the Java Sugar Experiment Station,[9] but instead of titrating the unreduced copper with iodine and thiosulphate the Munson and Walker method was selected for the Cu determination, it being in use almost exclusively in the U.S. in the official analyses of molasses. Three samples of molasses were submitted to nine collaborators for their results on the following procedure, No. 1 being a Cuban blackstrap, No. 2 a Cuban high-test molasses, and No. 3 a refiner's molasses (unfiltered syrup):

[1] U.S. Bureau of Standards, Washington. [2] *J. Amer. Chem. Soc.*, 1906, **28**, p. 663. [3] *Ind. & Eng. Chem.* (anal'y. ed.), 1938, **10**, p. 246. [4] *J. Res. Nat. Bur. Standards*, 1940, **24**, p. 579. [5] *J. Biol. Chem.*, 1921, **45**, p. 362. [6] *J Amer. Chem. Soc.*, 1935, **57**, p. 845. [7] *Zeitsch. Ver. deut. Zuckerind.*, 1917, **67**, p. 563. [8] Associate Referee, Sugars and Sugar Products, A.O.A.C. [9] "Methoden van Onderzoek," 6th ed'n, p. 365.

Transfer the sample (12 grms. of Nos. 1 and 2, and 8 of No. 3, each corresponding to 6 grms. of total sugars) to a 500 ml. wide-mouthed Erlenmeyer flask, using in all 75 ml. of water ; add 30 grms. of coarsely chopped Fleishmann's baker's yeast (free of starch), and mix with the molasses solution. Close the flask with a stopper provided with a delivery tube, the other end of which is immersed 1 cm. below water in a beaker.

Place the flask in a water-bath at 30°C., and allow to ferment for at least 4 hours, shaking the flask from time to time. When fermentation is complete, transfer the contents of the flask to a 250 ml. flask ; clarify with 15 ml. of neutral lead acetate (20 grms. per 100 c.c.), make to the mark at 20°C., and filter. De-lead the entire filtrate with about 0·5 grm. of potassium or sodium oxalate (finely powdered anhydrous), mix well, and filter again.

Determine the Cu-reducing power in two 50 ml. portions of the final filtrate by the Munson and Walker method, and report the Cu found in each determination. Run a blank using water instead of molasses. It may be necessary to correct for the yeast and lead precipitates, using the Scheibler double dilution method.

Results obtained show that weighing as Cu_2O generally gives the highest results, owing to the inclusion of mineral and organic matter in the precipitate. Ignition to CuO generally gives lower results than weighing as Cu_2O, owing to the elimination of organic impurities, but the results are still too high, as is shown by the volumetric determination of Cu in the precipitate.

Most collaborators reported difficulties due to foaming and violent bumping during boiling. This naturally affected the final results. The only way of eliminating this source of error is to carry out the reduction at a definite temperature below the boiling point of the mixed solution, e.g., by the method of QUISUMBING and THOMAS, already adopted by the Association.

F. M. HILDEBRANDT determined the unfermented reducing substances in the residues remaining after estimating the alcohol yield by the usual distillery method in all three samples. Results by this method (II) compared with those by the method described above (I) were as follows, expressed as a percentage of the total sugars present in the original molasses :

Sample.	Method I.	Method I (corrected).	Method II.
1	7·6	6·84	9·7
2	2·6	2·34	2·3
3	8·9	8·01	8·0

It is seen, therefore, that when a correction factor (0·9) is applied to the figures found by Method I, the results check with those by Method II for molasses 2 and 3, but not in the case of molasses 1, where there is a large difference. This question, therefore, requires further study.

pH Measurement in the Sugar Industry. A. NAGARAJA RAO and N. S. JAIN.[1] *Proc. 9th Conv. Sugar Tech. Assoc. India*, I, pp. 213-224.

This is a comparison of methods of determining the *pH* value of sugar factory products, each of which has its own particular liability to error. In the colorimetric, which is rapid and easily performed, the degree of accuracy is not of a high order. Using the electrometric method with the antimony electrode as the standard method, the following results were obtained :—

Nature of product.	C.P.R.	B.C.P.	B.T.B.	P.R.	*pH* using Antimony Electrode.
Raw Juice	5·4	5·2	—	—	5·2
Clear Juice	—	—	7·1	7·5	7·2
,,	—	—	6·8	7·3	7·1
,,	—	—	6·9	7·2	7·2
,,	—	—	7·2	7·6	7·6
Press Juice	—	—	7·3	7·7	7·6
Syrup (unsulph.)	6·5	6·2	6·4	—	6·6
,,	6·2	6·2	6·2	—	6·4
,,	6·5	6·4	6·4	—	6·4
Syrup (sulph.)	5·6	5·6	—	—	5·9
,,	6·3	6·2	6·2	—	6·2
,,	5·8	5·8	—	—	5·95

A source of error is introduced when different indicators are used to read the same range of *pH*, which error may vary with the indicator and the product. Thus it is found while B.T.B. and B.C.P. invariably give results lower than with the antimony electrode, the indicator P.R. tends to yield higher results. Another source of error in the colorimetric method is the presence in sugar factory products of colloidal substances which act similarly to proteins in adsorbing one of the differently coloured constituents of the indicator.

In the table below some results given by four different methods are compared, in regard to which the following comments are made by the authors : Almost as a general rule the colorimetric method has given lower results than the electrometric using the antimony electrode. On the other hand, the e.m. using the quinhydrone electrode yields higher results but these are very erratic, according to the product examined. Errors in the quinhydrone method may be due to the interaction between calcium salts and the hydroquinone, as well as to the present of colloids having an adsorbent effect similar to proteins.

Figures are also given showing the effect on the *pH* value of the dilution of the product when using the colorimetric method, from which figures the following conclusion is drawn : "In factory work in determining the *pH* of dark coloured syrups and molasses the common practice is to dilute the liquid sufficiently with distilled water before measurement. Our observations indicate that this method is likely to lead to inaccurate results and should be strongly deprecated."

Tests were not made with the e.m. method using the glass electrode, which, however, is acknowledged

[1] Imperial Institute of Sugar Technology, Cawnpore.

to be free from most of the sources of error common to other electrodes, and has been so simplified that accurate measurements are easily made even by in-

	Colorimetric.	Antimony Elec.	Quinhydrone Elec.	Hydrogen Elec.
Clear Juice	6·6	6·9	8·9	—
,, ...	6·7	6·75	10·0	6·77
,, ...	7·2	7·4	9·0	7·4
Press Juice	7·4	8·4	9·9	—
,, ...	8·0	8·4	9·9	8·3
,, ...	7·6	7·6	9·2	7·7
Syrup (unsulph.)	6·2	6·4	9·6	—
,,	5·8	5·9	6·7	4·9
,,	5·9	6·1	7·7	4·3
Syrup (sulph.) ..	5·6	5·95	7·7	—
,, ..	5·8	5·9	7·9	—
,, ..	5·8	5·9	6·7	—

experienced workers. Its use in sugar factory work is to be recommended in preference even to the hydrogen electrode apparatus.

Removal of Silica from Boiler Feed Waters. *The Betz Indicator*, 1941, **10**, No. 6.—This is a problem which until recently has resisted the efforts of water chemists for its complete solution. Sodium silicate, iron salts, magnesium salts, and a number of other compounds have been tried, but while removing the SiO_2 more or less completely the total solids of the water were increased. Quite recently, however, BETZ, NOLL and MAQUIRE propose the use of active magnesium oxide ("Remosil"). Advantages of this reagent used in conjunction with the standard lime-soda softening process are that the solids content of the treated water is not increased (being in fact somewhat reduced); that no additional equipment is required; that no increase in the hardness and alkalinity results; and lastly that the amount of lime and soda ash used in the softening remains the same. Besides this, the magnesium oxide is itself an efficient coagulent, which makes it unnecessary to use any other preparation of the same nature in the treatment.

Comparative Tests of Chemical Glassware. E. WICHERS, A. N. FINN and W. STANLEY CLABAUGH.[1] *Ind. & Eng. Chem.* (analy edn.), 1941, **13**, No. 6, pp. 419-422.—This paper describes the results of comparative tests of four brands of chemical glassware made in the U.S.A., three of which were borosilicate glasses including Pyrex and the fourth (Vycor) a 96 per cent. silica glass. These glasses were compared with respect to acid reagents (sulphuric, phosphoric and hydrochloric; alkaline (N/2 KOH, etc.) and nearly neutral NaCl buffered at various *pH* values; and also with respect to mechanical shock (striking a flask, beaker, etc., with the tip of a pendulum of fixed length swung through arcs of increasing length until broken). Results of all these tests are graphically shown, and the feature of them is their remarkable variation, in the different tests certain behaving well in some and less in others.

Determination of Surface Areas (of Activated Carbon, etc.). P. H. EMMETT and THOS. DE WITT.[2] (*Ind. & Eng. Chem.* (analy. ed.), 1941, **13**, pp. 28-33.—During the past few years a method for measuring surface areas of fine powders by means of low temperature adsorption has been developed by BRUNAUER and EMMETT and others.[3] It has been applied to a variety of non-metallic adsorbents including soils, various salts, and Darco.[4] Since the method is comparatively simple and rapid in operation, it is here utilized in measuring the surface areas of a number of industrically important finely divided materials, including carbon blacks, $BaSO_4$, and cement.

Colorimetric Determination of Nitrate in Water, etc. MARTHA B. SHINN. *Ind. & Eng. Chem.* (analy. ed.), 1941, **13**, pp. 33-35.—A method employing sulphanilamide and *N*-(1-naphthyl)-ethylenediamine dihydrochloride is proposed. These reagents have been found superior to sulphanilic acid and α-naphthylamine formerly employed, in that the colour developed is clearer, reaches its maximum intensity more rapidly, and remains stable for a longer time.

Spectrographic Examination of Fertilizers. F. E. HANCE. *Report of Committee-in-Charge of Expt. Station of the Hawaiian S.P.A.*, 1940-41, pp. 97-98. —In work on the presence of so-called "minor" or "micro-nutrient" elements in modern fertilizers, spectrographic examination showed traces of zinc in Canadian "Ammo-phos," rock phosphates and superphosphates; manganese in "Uramon" and Canadian "Ammon-phos"; and boron in Chile nitrate of potash, Trona sulphate of potash and Canadian "Ammonphos." Molasses from two plantations in Hawaii showed considerable amounts of silicon and iron, smaller amounts of manganese, and traces of copper, molybdenum and cobalt. Neither boron nor zinc were present in this by-product.

Use of Sugar in Meat Curing. C. ROBERT MOULTON. *Food Manufacture*, 1941, **16**, No. 5, pp. 107-109.—Discusses the direct effect of sugar on the flavour of cured meat by masking the harshness of salt and by controlling fermentative action, as well as having other important functions. Presence of dextrose is said to be essential in normal curing.

Filter-Cake Utilization. *Report of the Committee-in-Charge of the Experiment Station, Hawaiian S.P.A.*, 1940, pp. 25-26.—At the suggestion of Dr. H. L. LYON, two possibilities for utilizing filter-cake were investigated. In the first, this by-product was submitted to an aerobic fermentation in a small pilot plant, the gases produced being collected and analysed. Their composition was found to vary greatly, containing in one test 50 to 60 per cent. of hydrogen, and in another consisting mainly of nitrogen. In the second, the rate of decomposition

[1] National Bureau of Standards, Washington, D.C. [2] John Hopkins University, Baltimore, Md.
[3] *J. Amer. Chem. Soc.*, 1935, **57**, p. 1754; 1937, **59**, p. 1553. [4] *Ibid.*, 1937, **59**, p. 2682.

of the filter-cake by micro-organisms was studied by adding various fertilizers and maintaining in a moist condition, i.e., submitting the material to a composting treatment. When no fertilizer at all was added, the result of composting was to reduce the original volume of the cake to about half, and to effect a very complete decomposition, leaving little fibre. A material was thus obtained similar to a rich garden loam. When fertilizers, as sulphate of ammonia, sulphate of potash and superphosphate were added (5 to 12 lbs. per 100 of the cake), the decomposition was less complete than in the absence of any fertilizer. There would appear to be present sufficient nitrogen in the cake for its decomposition. Some results showing carbon-nitrogen ratios are given below, the optimum C/N ratio for normal plant growth being somewhere around 10 or 11 :—

	Before Composition	After Composition
Series A, no fertilizer added	23 7 : 1	11·5 : 1
Series B (5 per cent. sulphate of ammonia)	—	5·9 : 1

It may be found advantageous, therefore, to compost filter-cake for its application to fields. It was in fact found that cane variety 31-1389 when planted in filter-cake which had been composted for six months (Series A above) produced a growth which was judged superior to that observed with Makiki soil.

Correspondence.

A Matter of Terminology.

To The Editor,
"The International Sugar Journal."

Dear Sir,

In the April issue of *The International Sugar Journal* (Notes and Comments, page 103), I am taken to task for the use of the word "alternate" in place of "alternative," and of the specific name "*vasculorum*" in place of "*vascularum*," in the title of my paper "Alternate Hosts of *B. vasculorum*."

The use of the word "alternate" was deliberate. In this investigation, we were not specifically interested in alternative hosts as such, but in alternative hosts which might serve to carry-over the disease and then transmit it back to sugar cane. That is to say, in different genera acting alternately as the host. In further illustration, I might quote the case of downy mildew disease of sugar cane: both maize and Sudan grass may be infected with this disease and thus both act as alternative hosts for *Sclerospora sacchari*. Sporulation of the fungus is prolific in the case of maize, and transmission of the disease from maize back to sugar cane can readily be effected; but, during our studies, no sporulation has been observed on the diseased Sudan grass, and it would appear that sugar cane can not be infected from this source.

It is our contention that in such case maize acts as an alternate host and we believe that the use of the word in this sense falls within the Oxford English Dictionary definition "done or changed by turns, coming each after one of the other kind." Furthermore, a perusal of current phytopathological literature indicates that such use of the term "alternate host" is sanctified by usage.

In 1924, von Kirchner (*Zeits. Pflanzenkrank.*, 34, 260) expressed the opinion that the spelling of the species name of *B. vascularum* should be "vasculorum," and this view was later accepted by Elliott ("Manual of Bacterial Plant Pathogens," Baillière, Tindall & Cox, 1930).

In this connexion, we would refer your correspondent to the International Rules of Botanical Nomenclature as adopted by the International Botanical Congress. Herein is stated "the original spelling of a name or epithet must be retained, except in the case of a typographic error, or of a clearly unintentional orthographic error."

Prior to the publication of the title under dispute, we referred the matter of the spelling of "vasculorum" to the Director of the Imperial Mycological Institute. He replied, "We have followed Kirchner and Elliott with the spelling of "vasculorum" to replace Cobb's original "vascularum" because we believe his spelling was an unintentional orthographic error."

If we err in the spelling of "vasculorum" it must be conceded that we err in good company.

Yours faithfully,

C. G. HUGHES.
Assistant Pathologist.

Bureau of Sugar Expt. Stations,
Brisbane,
July 15th, 1941.

*** We are glad to publish the above letter. In the first place it shows the dangers accompanying the use of words which have both a common and rather vague meaning, and also a well-defined technical one. The explanation given by Mr. Hughes should remove doubts as to his employment of the word "alternate." With regard to the spelling of the specific name of the bacterium, we are glad to have the authority of the Director of the Imperial Mycological Institute for what is, undoubtedly, the correct spelling on etymological grounds, and we hope it will receive universal acceptance such as is not at present, as we noted, the case.—Ed., *I.S.J.*

Sugar-House Practice.

Bagasse Furnace Operation and Design.[1] K. S. Arnold. *Proc. 9th Conv. Sugar Tech. Assoc. India*, pp. 126-134.

Some Investigations.—During the 1939-40 crop the Imperial Institute of Sugar Technology, Cawnpore, conducted some investigations into the performance of step-grate furnaces, and a few of the results of representative types are given in the accompanying tables.

Type A.—Results obtained were good, but it is to be noted that with 14·8 per cent. of CO_2 the amount of CO was treble what it was with 14·0 per cent., and that the temperature had been lowered, thus indicating a falling off in efficiency with CO_2 beyond 14 per cent. Some sparks were observed passing with the gases. Alterations suggested are: provision of a dead-plate at the top of the grate, and the moving forward and lowering of the curtain wall in front of the feeding hole, so as better to shield the incoming bagasse against entrainment of finer particles, and the sloping forward of the check wall.

Type B.—Excess air being used was much too high, the result of introducing secondary air through holes at the front face of the check wall. Otherwise the design of the furnace is good, though alterations which may be suggested are: provision of curtain wall at feeding hole, and the sloping forward of the check wall.

Type C.—Although the volume relative to the heating surface is appreciably larger than is usually provided, the results were nevertheless good, the furnace gas temperature being high, indicating that large volume is beneficial rather than the reverse. In this furnace the width between furnace walls was 6 ft., and between the boiler walls, 10 ft., resulting in two stagnant corners being formed at either side where the walls meet. This could be improved by tapering the width of the combustion chamber from 6 to 10 ft., starting from behind the check wall.

Table I.—Results of Investigations.

Type.	Flue gas composition: CO_2 per cent.	O_2.	CO per cent.	Excess air per cent.	Temperatures °F.: Furnace gas.	Flue gas.	Drafts at rear (in.)	Appearance of combustion chamber and furnace gases.
A	14·0	4·8	0·2	28	1920	500	0·6	Walls brightly incandescent. Occasional hazy flame and some glowing sparks.
	14·8	3·6	0·6	18	1880	470	0·6	
B	10·0	9·0	0·1	73	1890	460	0·75	Walls brightly incandescent. No flames, but some glowing sparks.
C	12·4	6·2	0·2	40	2030	490	0·5	Walls brightly incandescent. No flames, and only a few sparks.
D	8·8	10·6	0·4	96	1902	450	0·7	Walls black. Dull red flames extending to boiler tubes and large quantity of sparks.
E	13·0	6·5	0·0	44	1920	470	0·5	Walls brightly incandescent. Intermittent hazy flame, with large quantity of flaming sparks.
	15·4	2·0	1·0	5	1870	470	0·45	
F	11·0	8·2	0·2	62	2120	650	0·8	Walls brilliantly incandescent. Hazy flames, and some glowing sparks.
	15·9	2·3	1·4	8	2100	620	0·6	
G	12·1	7·0	0·2	48	2050	500	0·7	Walls brilliantly incandescent. No flames, and only occasional sparks.

Table II.—Particulars of Furnaces.

Type.	Boiler Heating Surface, sq. ft.	Furnace Grate Area, sq. ft.	$\frac{\text{Heating Surface}}{\text{Grate Area}}$.	Heating Surface. Total Combustion Volume, ft per cub ft.	$\frac{\text{Combustion Chamber Volume}}{\text{Furnace Volume}}$.
A	5160	77	67	3·5	1·3
B	3140	36	87	2·8	3·0
C	3900	72	54	2·5	2·5
D	3900	54	72	5·4	2·0
E	3140	64	49	3·9	2·7
F	5000	56	90	5·1	3 7
G	4000	71	56	3·1	3·3

Type D.—Performance poor, the furnace gas temperature being extremely low; and, despite a considerable excess of air, the CO content was appreciable. There was no incandescence of walls, and the flames from the grate extended to the boiler tubes. Bagasse particles could be seen falling like rain from the gases passing above, burning when separated, but on floating downwards becoming extinguished due to the absence of oxygen in the combustion chamber. When withdrawn the ash was found to be composed almost entirely of carbon, representing a serious loss of fuel. Faulty furnace design throughout.

Type E.—Here again, though results were good as far as figures go, the appearance of the combustion chamber was poor on account of the large quantity of burning bagasse particles passing in the flow of

[1] Continued from *I.S.J.*, 1941, pp. 286, 320.

gases, these being discharged from the chimney and littering the surroundings. While the proportions of this furnace are satisfactory, the shortcoming of the design is that the gases are permitted to flow in streamline from grate to heating surface, and at no point interrupted and changed in direction so as to promote turbulence. As a result, light bagasse particles are easily entrained by the draught, and carried straight to the boiler. Alterations suggested are the moving forward of the furnace proper, the introduction of a forward sloping check wall, and the extending of the furnace roof.

Type F.—The high figure of the flue gas temperature for a boiler operating at 160 lbs. per sq. in. is to be noted. The fact that this was not lowered appreciably by reducing the draught until the excess air was quite inadequate for satisfactory combustion indicated that either the grate area was too large, the tubes were dirty or scaled, or that the gases were not coming into full contact with the entire heating surface of the boiler. It is possible that in their path to the front bank of tubes the gases were not deflected sufficiently low to cause them to flow over the lower portions of the tubes in this band, the heat transmission in this area thus being too low. Improved baffling to correct this is indicated.

Type G.—This furnace gave good results.

Disposal of Cane Molasses Distillery Slops. N. SRINIVASAN.[1] *Sugar*, 1941, **36**, No. 5, pp. 31-32.

One of the methods of disposal is to run the "slops" into the nearest stream, but this obvious and convenient procedure is becoming increasingly difficult owing to the inconvenience it causes. It seriously depletes the oxygen content of the water, destroys fish life and altogether the practice is regarded as a nuisance.

Biochemical methods designed principally to detoxify the effluents before running them into a stream or putting them on the land have been introduced. In the Srivastava and Sen system,[2] for example, the effluents are separated from suspensions, the organic matter bacterially oxidised in tanks with vigorous aeration and the colloids precipitated by lime.

But from the composition of the distillery spent wash it is evident that it contains useful fertilizer ingredients, mainly potash, so that if these could be returned to the soil from which they originally came it would be an economical means of disposal. Wash as it comes from the stills cannot of course be used on the field on account of its high acidity, and because of the high cost of transporting such large volumes of liquid to locations in many cases miles away.

Ultimately, therefore, the question of recovering the potash (amounting to about 6 grms. per litre) reduces to one of evaporating the water from the solution. This has been current practice in Europe and in the U.S.A. in grain distilleries, where the slops (containing 4 to 6 per cent. of solids) are evaporated to a thick liquor which is mixed with screenings for use as fertilizer or cattle-food.

In the evaporation system usually a triple effect is used to concentrate the slops to a thick liquor, which is then burnt in a Porion furnace, as commonly used in paper mills for recovery of soda from the black liquor. Combustion can be carried on with little expenditure of extra fuel, on account of the high content of organic matter present, only about 0·5 to 0·75 ton of coal for 2500 galls. of the concentrated slops being used. The residue has a K_2O content of 30 to 40 per cent., and the approximate cost of the plant for dealing with 23,000 galls. of molasses per day, giving 1·32 tons of 30 to 40 per cent. potash, would be Rs. 78,000.

In such a scheme the largest item of expenditure is of course the cost of the steam for evaporation, and efforts have been made to find some means of lessening this outlay. Thus REICH[3] has devised a process in which the fermented wash, instead of being de-alcoholized in a still is sent to the first effect of a triple or quadruple. Practically all the alcohol with the water will condense in the calandria of the second effect, giving a condensate of 29 to 30 per cent. of alcohol (by vol.), the third effect condensate will contain only 1 to 15 per cent., and the fourth will have none at all. This second condensate is sent to a rectifying column, 96 per cent. alcohol being taken out from the top as usual, while the third condensate is used for diluting the molasses solution for the next batch of fermenters. Lastly, the concentrated slops from the fourth effect may be sent to the Porion furnace for incineration there. In this way about 44 per cent. of the cost of steam as compared with the ordinary procedure can be saved, besides which there is a reduction of 100 per cent. in the volume of wash handled.

Spray Ponds. S. V. FEVRE. *Proc. Queensland Soc. Sugar Cane Tech.*, 12*th Conf.*, pp. 201-203.

Every spray pond presents an individual problem, and therefore any general rules which may be given regarding their design and installation must be modified to suit particular cases. However, the following features apply to most conditions :—

(1) Cooling is affected more by air temperature and humidity than by the temperature of the water coming from the condensers.

(2) In an atmosphere of 80 to 90 per cent. relative humidity, the temperature of the water may be lowered to within 12 to 13°F. of the dry bulb temperature.

1 Chemist, Mysore Sugar Co.'s Distillery, India. 2 *Jl. Science and Technology, India*, 1936, **2**; *I.S.J.*, 1937, p. 486.
3 *Chem. & Met. Eng.*, 1929, **36**, 1937, **44**; and U.S. Patents, 1,930,861 (1933) and 2,010,929 (1935).

(3) In an atmosphere of 20 to 30 per cent. relative humidity, the temperature of the water may be lowered about 8°F. below dry bulb temperature. A properly laid out pond should be able to cool water down to within 3 to 5°F. of the surrounding air temperature.

The cooling efficiency of a spray system is expressed by the following formula :—

$$\frac{T_1 - T_2}{T_1 - T_3}$$

Where T_1 is the initial temperature of the water, T_2 is the final temperature of the water, and T_3 is the wet bulb temperature. The final temperature of the water depends upon many factors including the following :—

The initial temperature of the water ; the existing atmospheric conditions ; the arrangement of the nozzles over the pond ; the water pressure at the nozzles ; and the storage capacity of the pond.

It is desirable to utilize nozzles which give a fine, evenly distributed spray in the form of a hollow cone. These, however, are incapable of passing large particles of suspended matter, and the pond must be kept free of weeds and other debris. Nozzles designed to handle a reasonable amount of dirt cannot break up water into fine particles unless excessive pressures, of the order of 15 to 20 lbs. per sq. in. be employed. Normally a pressure of 7 to 8 lbs. is sufficient for adequate cooling.

Average spray pond areas range from 3·5 to 4·5 sq. ft. per g.p.m. handled. A depth of 3 ft. is suitable. Consider an installation of 2 in. nozzles, with outlet orifice 0·8 in. diam., each discharging 50 g.p.m. at 7 lb. per sq. in. pressure. The feeder mains would usually be 20 ft. apart, with a nozzle pitch of 12 to 14 ft. Such an arrangement provides ample space for air lanes between the sprays.

Even on calm days all sprays produce an upward air current which is most necessary for proper cooling. Close spacing of sprays restricts the air lanes, so that the system becomes vapour locked, and the cooling thereby impaired.

A more satisfactory final water temperature than that given by single spraying may be obtained with the mixed spray system, wherein the hot condenser water is mixed with an equal volume of cooled water from the spray pond. The mixture is pumped once through the sprays, and emerges from the pond with a temperature several degrees below that obtained with single spraying. Obviously the mixed spray system requires greater pond area, larger pipes, and more sprays. The pump capacity must also be increased accordingly.

Locomotive Maintenance. F. JORGENSEN. *Proc. Queensland Soc. Sugar Cane Tech 12th Conf.*, pp. 175-176.

The Boiler.—The steam-producing section of the locomotive often is the cause of more trouble than the engine section, due mainly to bad feed water and fluctuation of steam pressures through heavy pulling on steep grades. Some of the most common failures are due to leaky tubes, broken wall stays, broken palm stays, cracking of plates from edge to rivet holes, burning away of firebox front plate around fire door, and cracked tube plates.

Some of the most common causes of leaks in tubes are bad feed water, burning away of the beading on tubes at the firebox end, and the breathing of tube plates. The burning away of tubes can be overcome by lowering the fire level, and fitting a beaded ferrule into the existing tubes. Accumulation of scale between the walls of the firebox through faulty washing out is generally the cause of failure of wall and palm stays.

It is a good practice to fit two to three longitudinal stays, according to the area of tube plate. The failure of the palm stays is often caused by the stay bracket being of too rigid construction, not allowing for any vertical expansion of the tube plate. This trouble can be overcome by constructing the palm stay bracket of 2 in. × $\frac{5}{8}$ in. material, with the end reinforced to take the stay, and by carrying the bracket along the barrel of the boiler for a distance of 18 in.

The cracking of front and back firebox plates from the edges of the rivet holes is common about firing level, and can be overcome by filleting the edge plate with a radius of $\frac{1}{4}$ in., thus eliminating sharp edges which can be attacked by the flames. Protector plates should be fitted to firebox doors to carry away the heat, and also to prevent wear on the plates from slice bars. Rivets should be countersunk on the furnace side, so as to allow the protector plate to fit snugly against the furnace plate. Burnt firebox plates and cracked copper tubes plate can be satisfactorily built up or welded with silicon copper rod.

Running Gear.—The taking up of wear on engine parts has been simplified by the introduction of welding. For instance, the flanges of wheels may be built up by welding where excessive wear has taken place, thus preventing too great a reduction in diameter when turning down to get a standard wheel. The old method of turning wheels with a gradual taper of two to three degrees has gone by the board, and wheels should be turned parallel to about the width of a 40 lb. rail, and then tapered off to the edge of the wheel.

Piston, side rod brasses, horn cheeks, etc., can also be built up to avoid replacing with new castings. There are several methods of taking up wear on the sliding surfaces of axle boxes, the most common of which is is to attach a strip of phosphor-bronze or steel to the face of the horn cheek ; this is held by two countersunk bolts and kept in place by spigots attached to the strip, and fitting into recesses in the horn check. The strips can then be packed out with

shims to the required clearance. Attempts have been made to improve on the half brass for side road bearings; but this type of bearing is still superior to the bush or floating bush. The life of a bush is generally only one season, whereas a half brass can be used from four to five.

Massecuite Investigations. W. L. McCleery. *Report of the Committee-in-Charge of the Experiment Station of the Hawaiian S.P.A.*, 1940-41, pp. 105-107.

"Existing crystallizers can be fitted with rotary coils having a ratio of 0·5 to 0·6 sq. ft. surface area per cub. ft. of capacity and with the crystallizer shell insulated with Canec (bagasse fibre-board), the massecuite temperature can be successfully held under very complete control. A given ratio of revolving coil surface has at least double the effectiveness of stationary surface so that the above ratio is at least double that of any previous installation.

When coils of this surface ratio are used as cooling coils they reduce the massecuite temperature in 6 to 8 hours to a pre-determined minimum figure, which from a safety standpoint was about 120°F. (49°C.). Warm water, approximately 2 to 3° higher than the massecuite temperature (about 122°F. or 50°C.), is circulated through the coils to maintain the massecuite at this minimum temperature. Crystallization proceeds at a fast rate, without danger of breakage of equipment from excessive viscosity, until the massecuite saturation temperature has dropped to the optimum point which has been determined, for practically all our factories.

This is a few degrees above or below 130°F. (54°C.), after which the massecuite is ready for reheating to the saturation temperature with warm water circulated through the coils at not over 3 to 4°F. above the saturation temperature about 133°F. (56°C.). On reaching this it is ready for purging. This small difference between heating water and saturation temperature is essential and requires the large coil-surface ratio to avoid local overheating.

To shorten the total time in the crystallizer, reheating can be done either in an independent heater or, preferably, in the mixer over the centrifugals. With either method the heating surface requirement is about half that necessary when massecuites have been allowed to cool in crystallizers without temperature control to approximately air temperature.

For a mixer heater, the coil-surface ratio should be about 5 sq. ft. of revolving coil surface per cub. ft. of massecuite per hour, preferably divided between an upper and lower coil, with slotted plates of the Stevens patented type above each coil, thus giving two-stage heating and insuring an even temperature massecuite to the centrifugal baskets. The revolving stub heater of the Blanchard heat exchanger type on trial at two factories has interesting possibilities due to its low construction cost. The total time in process, exclusive of any reheating, is shortened with this high coil-surface ratio crystallizer to not over 48 hours and with further practice can probably be reduced to 36 hours. This represents a 50 to 75 per cent. saving in capacity compared with present operation of crystallizers of the usual type.

With this type of crystallizer working at a high minimum temperature of about 120°F. (49°C.), practically the highest density massecuites that can be boiled in any reasonable length of time, containing 92 to 93 per cent. total solids, can be handled without danger of mechanical trouble and, except for particularly viscous material encountered occasionally, these massecuites can be purged successfully at the optimum saturation temperature of about 130°F. (54°C.) with modern centrifugal equipment."

Recording Maintenance. H. G. Brandon and J. O'Neill, Jr. *Proc. Queensland Soc. Sugar Cane Tech. 12th Conf.*, pp. 171-173.—Each foreman mechanic is provided with a number of cards, approximately 10 in. × 6 in., which are fitted into a 26-gauge galvanized iron holder. He daily records particulars of his repair work on different cards, each of which relates to one unit of plant. On completion of the work on a unit, the engineer may add a note to the card following his inspection of the plant, after which the card is handed over to the timekeeper for filing. Then a printed or typed loose leaf form is filled in with data taken from the cards, together with general information, such as make of machine, size, materials of construction, etc. The cost of maintenance, either in detail or as wages and material, should also be added in the space provided for same, such data being supplied by the timekeeper, accountant, or person responsible for the costing of maintenance and manufacture. Each sheet may have a following sheet, headed "Remarks," and marked with a unit number. On this sheet may be noted details of inspections during the crushing season, records of breakdowns, and other information which may be of value.

Use of Alcohol as Fuel for Farm Engines. Alexandro B. Catambay and Sawaeng Kulthongkham.[1] *The Philippine Agriculturist*, 1941, **29**, pp. 672-683.—Very little work has been done on the use of alcohol for single cylinder stationary engines as used on many farms in the P.I., and as originally designed to use gasoline as a starting fuel and kerosene for running. It was possible to start cold engines using: straight commercial ethyl alcohol (sp. gr., 0·821 = 93·75 per cent. by volume); "Alkohl" motor fuel (alcohol containing 5 per cent. of gasoline), and a mixture containing 25 parts by volume of kerosene, 75 of ethyl alcohol, and 25 of acetone. In general, alcohol, and mixtures containing a high percentage of it, produced higher thermal efficiencies than kerosene. Generally the specific fuel consumption of an engine with alcohol and mixtures containing a high percentage of alcohol is greater than with kerosene.

[1] College of Agriculture, University of the Philippines, Laguna, P.I.

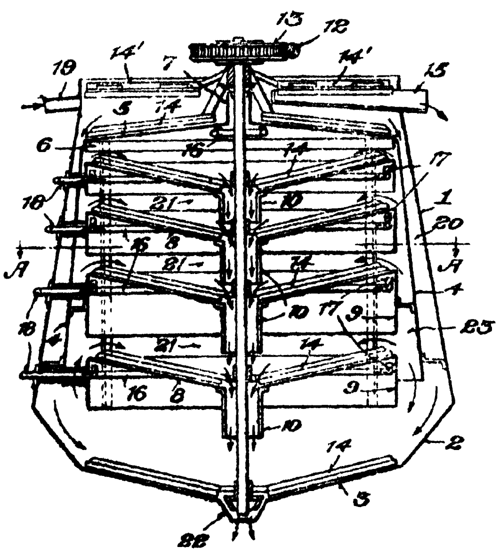
Review of Recent Patents.

Copies of specifications of patents with their drawings can be obtained on application to the following—*United Kingdom*: Patent Office, Sales Branch, 25, Southampton Buildings, Chancery Lane, London, W.C.2 (price 1s. each). Abstracts of United Kingdom patents marked in our Review with a star (*) are reproduced with the permission of the Controller of H.M. Stationery Office, London, from the Group Abridgements issued by this Department. Sometimes only the drawings are so reproduced. *United States*: Commissioner of Patents, Washington, D.C. (price 10 cents each).

UNITED STATES.

Clarifier. ARMANDO S. VILLASUSO, of Ingenio Concepcion, Tucumán, Argentina. 2,236,202. March 25th, 1941.

Referring to the drawing shown by way of example, the new clarifier comprises a frusto-conical deposit tank 1, with the lower end closed by two casing portions 2 and 3. Within said tank is arranged annular element 4 the upper base of which is covered by 5. In the interior of the assembly are a plurality of trays 8, suitably spaced, each of frusto-conical shape, with the apex towards the bottom, while the central portion has adapted thereto a tubular conduit 10, extending downwardly and partially entering into the adjacent trays.



Axially extending through conduits 7 and 10 is a vertical shaft 11 which receives a slow rotary motion by a suitable mechanism. On shaft 11 are radial blades 14, acting as scrapers on the upper face of each tray 8 as well as on the cover 5 and bottom 3 of tank 1. The upper portion of tank is provided with similar blades 14′ acting on the foam and facilitating its discharge through channel 15. Beneath each tray 8 is an annular conduit 16 from the upper portion whereof extends upwardly a plurality of small intake nozzles opening into the angles formed by said tray and the corresponding flange 9. Said nozzles act as extractors for the clear juice, which is carried out of the tank through tubular conduits 18.

Operation takes place in the following manner: Liquid to be clarified enters tank 1 through upper conduit 19, falling into the chamber 20 formed between the wall of said tank 1 and the internal body 4, and the solid or semi-solid matter which may accumulate on the cover 5 is moved into the chamber through the action of the upper scraping blades 14. The passage of juice to the lower part of the tank is effected in such a manner that the stirring caused when striking the bottom thereof is minimized, due to the fact that in their downward motion said substances slide on inclined surfaces 4, 2 and 3, and are smoothly deposited on the lower portion thereof.

Upon continuing the admission of liquid, same rises also without stirring through the internal portion of the tubular body 4, and will successively enter the annular spaces 21, formed between the free upper borders of each of the trays 8, and the lower border of the adjacent flanges 9, filling each of the trays. The juice is thus allowed to stand until a complete sedimentation has been obtained. In such condition, the heavier substances are deposited on the lower part of each tray, and once the juice has reached the desired degree of clarification, it is sucked through the intakes 17, and extracted through the tubular conduits 16 and 18.

In turn, the residual sludge deposited on the trays 8 is eliminated through the central conduits 10, reaching the bottom 3 of the tank 1, from where it is finally discharged through the lower opening 22; the different scraping blades 14 co-operate in this elimination, by carrying said residue to the respective discharges. Finally, the foam which is eliminated through overflow channels 15, driven by rotary blades 14. Tubular mouth 7 formed in the central part of the cover 5 allows the expelling of the air contained in the tank 1 during its filling.

Claim 1: Clarifying apparatus for sugar cane juices and the like and including an outer casing having an inlet conduit and an outlet conduit at its upper end for the effluent juices, said casing having a closed lower end provided centrally with a sludge outlet, a series of decantation trays arranged in vertically spaced relation within said outer casing, said trays being all of the same diameter and of inverted frusto-conical form, a frusto-conical inner casing arranged in the space between the trays and outer casing and having a frusto-conical top provided with an upwardly extending and centrally disposed outlet tube, outlet tubes each extending downwardly from a respective tray at the centre thereof, a shaft extending through said outlet tubes, scrapers carried by said shaft and extending over the trays, and means to drive said shaft.

The American Sugar Quota.

The American sugar quota, which governs the supply of sugar for consumption in the United States and apportions the amounts amongst the various producers, domestic, overseas and "foreign," has for the year 1941 been subjected to an unprecedented series of revisions—all upward--till the last one, made effective on August 29th, provides the largest quota since the inception of the system in 1934, viz.. 9,002,976 short tons raw value.

The final quotas since 1934 have been for each each year as follows, the figures representing the total of sugars from Offshore areas, U.S. beet and Continental cane :—

	Short Tons Raw Value.
1934	6,476,000
1935	6,359,261
1936	6,812,687
1937	7,042,733
1938	6,780,566
1939	6,755,386
1940	6,471,362

For 1941 the initial quota, which was announced on December 7th, 1940, was 6,616,817 short tons. On March 19th last the first revision was announced, increasing the quota by 235,072 tons, to 6,851,889 tons. On April 11th the Philippine deficiency of 73,232 tons was re-allotted to Foreign countries (other than Cuba). On June 9th was announced a further revision, increasing the total by 273,672 tons to 7,125,561 tons. On June 27th a further Philippine deficiency of 42,173 tons was re-allotted to Foreign countries. On July 19th a further upward revision was made, to 7,627,563 tons, an increase of 502,002 tons. This was followed on July 30th by an increase to 8,006,836 tons, with re-allotment of deficits in the quotas of mainland cane areas and Hawaii and in the duty-paying portion of the Philippine quota. Finally, on August 29th there was a further quota increase of 996,140 tons, to 9,002,976 tons. We give in the adjoining Table details of the principal quota allotments made for this year.

It should be mentioned that in the quotas shown for July 30th and August 29th the effect of the re-allotment of deficits in respect to Mainland cane, Hawaii and the Philippines is as follows: ***Mainland cane***, July 30th, 445,000 tons comprises quota of 503,408 tons less 58,408 tons re-alloted to other domestic areas and Cuba; August 29th, 445,000 comprises quota of 566,038 less 121,038 similarly re-alloted. *Hawaii*, July 30th, 993,522 comprises quota of 1,123,878 less 130,356 re-al'oted to other domestic areas and Cuba; August 29th, 993,522 is quota of 1,263,700 less 270,178 similarly re-alloted. *Philippines*, July 30th, 982,663 tons is quota of 1,233,875 tons less 251,212, representing duty-paying portion of quota, re-alloted to foreign countries other than Cuba; August 29th, 982,633 tons is quota of 1,387,383 less 404,720, representing duty-paying portion of quota, re-alloted to foreign countries other than Cuba.

These successive increases have raised materially the amount of sugar available for consumption during 1941 and compare with the 6,736,000 short tons of sugar actually consumed in 1940. The reasons given officially for authorizing such larger amounts are not only the expectations of an increased consumption, but also the facilitation of increased working stocks in the hands of refiners, manufacturers, wholesalers, retailers and households. It may be assumed that the state of stringency occasioned by the world war and the increasingly difficult shipping outlook have made advisable the building up of larger visible and invisible stocks in the United States. With regard to the revision of August 29th, Lamborn writing on September 2nd stated that at the moment it was not known whether the continental beet area, Puerto Rico and foreign countries other than Cuba would deliver this year any additional sugar as a result of their increased quotas, but the revision would enable Cuba to market in the U.S.A. some 375,609 tons more. This, of course, assumes that Cuba will be prepared to part with that sugar at the ceiling price which the American Office of Price Administration (OPA) has fixed for the time being.

U.S.A. SUGAR QUOTAS, 1941.

	Initial Quota 1941 Short Tons.	Revision June 9th, 1941. Short Tons	Revision, July 30th, 1941. Short Tons.	Revision, August 29th, 1941. Short Tons.	Long Tons.
Domestic Beet	*1,549,898	1,652,571	1,925,499	2,230,037	1,991,104
Domestic Cane	420,167	448,000	445,000	445,000	397,322
Hawaii	938,037	1,000,177	993,522	993,522	887,073
Puerto Rico	797,982	850,844	991,365	1,148,160	1,025,143
Virgin Islands	8,916	9,507	11,076	12,829	11,454
Philippines	1,006,931	1,024,836	982,663	982,663	877,378
Cuba	1,869,060	2,038,230	2,374,852	2,750,461	2,455,769
Foreign full duty	25,826	101,396	282,859	440,304	393,129
	6,616,817	7,125,561	8,006,836	9,002,976	8,038,372
Long Tons	5,907,872	6,362,108	7,148,961	8,038,372	

Stock Exchange Quotations of Sugar Company Shares.

LONDON.

Company.	Quotation October 20th 1941		Quotation September 22nd 1941		1941 Dealings Highest.	Lowest
Anglo-Ceylon & General Estates Co. (Ord. Stock) ..	25/9 — 26/9	..	25/0 — 26/3	..	26/3	— 23/9
Antigua Sugar Factory Ltd. (£1 Shares)	½ — ¾	..	½ — ¾	..	11/6	— 8/9
Booker Bros., McConnell & Co. Ltd. (£1 Shares)....	2½ — 2⅝	..	2⅜ — 2⅝	..	52/6	— 47/6
Caroni Ltd. (2/0 Ord. Shares)	1/6 — 2/0	..	1/3 — 1/9	..	1/7½	— 11½
(6% Cum. Pref. £1 Shares)	21/3 — 22/3	..	21/0 — 22/0	..	22/6	— 20/3
Gledhow-Chaka's Kraal Sugar Co. Ltd. (£1 Shares)..	$1\frac{3}{16}$ — $1\frac{5}{16}$	..	$1\frac{3}{16}$ — $1\frac{5}{16}$	..	24/6	— 22/0
Hulett, Sir J. L. & Sons Ltd. (£1 Shares)	26/9 xd 27/9	.	28/0 — 29/0	..	29/4½	— 22/1½
Incomati Estates Ltd. (£1 Shares)	⅛ — ¼	..	⅛ — ¼	..	4/0	— 3/6
Leach's Argentine Estates Ltd. (10/0 units of Stock)	7/9 — 8/6	..	7/0 — 8/0	..	7/3	— 5/0
Reynolds Bros. Ltd. (£1 Shares)	36/0 — 38/0	..	36/0 — 38/0	..	38/0	— 32/7½
St. Kitts (London) Sugar Factory Ltd. (£1 Shares) ..	1⅝ — 1⅞	..	1⅝ — 1⅞	..	35/0	— 34/3
Ste. Madeleine Sugar Co. Ltd. (Ordinary Stock)	15/6 — 16/6	.	15/6 — 16/6	..	16/3	— 11/9
Sena Sugar Estates Ltd. (10/0 Shares)	5/10½ — 6/4½	..	5/6 — 6/0	..	6/6	— 4/0
Tate & Lyle Ltd. (£1 Shares)	58/0 — 59/0	..	58/0 — 59/0	..	60/3	— 46/0
Trinidad Sugar Estates Ltd. (Ord 5/0 units of Stock)	5/6 — 6/0	..	5/3 — 5/9	..	6/0	— 5/0
United Molasses Co. Ltd. (6/8d. units of Stock)	26/9 — 27/3	..	26/6 — 27/0	..	28/9	— 21/9

NEW YORK (Common Shares).†

Name of Stock.	Par Value		Closing Price September 30th, 1941		1941 Highest for the Year		Lowest for the Year
American Crystal Sugar Co	No par	....	18⅝	..	19½	..	9½
American Sugar Refining Co.	$100	..	21½	..	22⅛	..	13
Central Aguirre Associates	No par	...	18	..	22¾	..	15½
Cuban American Sugar Co.	$10	....	7¼	..	8½	..	3½
Great Western Sugar Co.	No par	....	26	..	28	..	19¾
South Puerto Rico Sugar Co.	No par	....	19½	..	21	..	13

† Quotations are in American dollars and fractions thereof

United States, All Ports.

(Willett & Gray)

	1941 Long Tons		1940 Long Tons		1939 Long Tons
Total Receipts, January 1st to September 27th	3,714,528	...	2,897,195	..	3,083,749
Meltings by Refiners ,, ,, ...	3,582,322	....	2,921,659	....	3,003,645
Importers' Stock, September 27th................	107,100	....	76,605	....	27,146
Refiners' Stock ,, ,, ...	291,801	....	335,500	....	252,940
Total Stock ,, ,, ...	398,901	....	412,105	....	280,086
	1940		1939		1938
Total Consumption for twelve months	5,712,587	...	5,648,513	....	5,604,051

Cuba.

(Willett & Gray)

	1941 Spanish Tons		1940 Spanish Tons		1939 Spanish Tons
Carry-over from previous crops.......................	1,184,393	....	588,293	....	729,172
Less Sugar for Conversion to Molasses	80,941	....	— —	....	— —
	1,103,452	....	588,293	....	729,172
Authorised Production	2,399,004	....	2,753,903	....	2,696,517
	3,502,456	....	3,342,196	....	3,425,689
Exports since January 1st	2,353,095	....	1,774,233	....	2,131,634
Stock (entire Island) September 27th	1,149,361	....	1,567,963	....	1,294,055

The Market in New York.

Rather wide fluctuations have marked trading in the No. 4 World Futures Contract during the period under review, with values reaching new high levels on September 29th when 2·62 c. was quoted for December, following rumours that the sale of 200,000 tons Philippine sugars to Russia was being negotiated; that the United States duty on Cuban sugars might be reduced by 0·15 c. to 0·75 c. per lb. and that the United States were negotiating for the purchase of the 1942 Cuban and San Dominican crops. Whether or no these rumours have any substance we have not yet heard but the subsequent downward drift of the market suggested that any further developments were not of a sufficiently definite nature to maintain the initial advance. From the figure quoted above, December delivery dropped to 2·15 c. by October 16th when the market was weak in sympathy with a general selling wave in the United States, but quite a substantial recovery has since been witnessed which may be due to renewed tension in the Far East. Closing quotations on October 23rd were :—

December	2·54	against	2·33	September 25th
March	2·53	,,	2·25½	,,
May	2·52½	,,	2·25	,,
July	2·53	,,	2·26	,,
September	2·54	,,	2·28	,,

Presumably owing to the tight Cuban statistical position at the end of the year and with a view to preventing any unduly speculative rise in the December quotation, the New York Exchange Board on October 8th suspended trading in that delivery except for the liquidation of outstanding contracts.

There have been no major developments in the United States domestic market during the past month and 3·50 c. c.i.f. remains the nominal spot quotation.

According to the latest reports available, the general Refined quotation remains unchanged at 5·35 c. with little business doing.

C. Czarnikow, Ltd.

London, E.C.3.
24th October, 1941.

Alcohol from Sisal.—In a recently published U.K. patent, it is claimed that a good yield (about 3 per cent. by volume) of methyl alcohol can be obtained from sisal, aloe, and some other plants simply by boiling the disintegrated material with a 2 per cent. solution of sodium carbonate at atmospheric pressure. The vapours evolved are passed through a fractionating column, according to usual distillation practice.

Cotton-growing in Queensland.—One effect of the war is the necessity felt in Australia to develop the production of primary products, so as to reduce the need to import. This particularly applies to cotton which, though possessing an unlimited market in Australia, was till a few years ago practically all imported to the Commonwealth. The shipping difficulties which hamper the export of primary products, such as sugar, wool, etc., also equally affect the importation of raw cotton, so the Commonwealth Government is anxious to increase the acreage and production of raw cotton in Queensland, where, particularly in the southern and central districts, it can replace the production of other primary products at present grown.

Marketing Queensland's 1941 Crop.—It becomes increasingly clear that though Queensland this year has allowed for a peak production of 737,000 tons of sugar, it is very doubtful whether the principal purchasers of the export surplus (the United Kingdom and Canada) will be able to ship sufficient quantities to absorb all that surplus. The question of storage is, therefore, an urgent problem and the Commonwealth Government has announced that it is prepared to construct additional storage accommodation for 40,000 tons of raw sugar, provided the sugar industry will erect storage of at least an equal capacity. The outlook for the 1942 crop is no better, and the sugar industry in Queensland is being seriously urged to restrict their output that year, as any excess of sugar would jeopardize their economic position.

Solidified Molasses.—What is described as "molasses with all the waste liquids removed, 100 per cent. digestable" is being sold by an agricultural supply company in Brisbane at the price of 18/6 per 1¼ cwt. container.

Roberts Centrifugal Processes.—It is claimed that with the following Roberts centrifugal processes half of the centrifugal machines at present in use in any sugar-house, and approximately 25 per cent. of the sugar-end equipment, can be eliminated: (1) a purity control process by which final cane massecuites will yield a 98° purity sugar in one single operation without affecting the purity of the final molasses; (2) an affination process for sugar refineries which produces a higher purity wash-sugar with a great reduction in affination syrup quantity; and (3) a white sugar process which puts 25 per cent. more sugar in the bag from each pan boiling with 30 per cent. less liquors to be put back to process.

Obituary.—William MacNab, F.I.C., M.Inst.Chem.E., who recently died at the age of 83 at Winter Hill, Cookham Dene, was born in Greenock, where in his early days he had been engaged in one of the sugar refineries. Later, he went to Magdeburg, Germany, where he opened a laboratory for the analysis of raw beet sugars, and at one time was chemist to Clyde Wharf sugar refinery. Subsequently he became interested in explosives, and in the last war became technical adviser to the Explosives Supply Department of the Ministry of Munitions.—Philippe Orth died recently at Courseulles-sur-Mer, France. His name is known to readers of this *Journal* as the author of a number of useful papers dealing with the solubility and the viscosity of sugar solutions, with the determination of sugar in carbonatation scums, and with various aspects of the crystallization of sugar. He had been consulting chemist to the Sucreries et Raffineries Say and to the Sucreries et Raffinerie d'Egypte.

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Notes and Comments.

The War.

At the beginning of October HITLER broke a long silence to assure his apprehensive countrymen that they were on the eve of a decisive victory in Russia. At that time the principal drive was against Moscow and this metropolis of Russia was in sufficient danger to make it advisable for some of the Government offices and the Diplomatic Corps to evacuate to Kuibishev (Samara) some 550 miles further east. But after two months more of desperate fighting, mostly in adverse weather, neither a frontal attack nor an attempt at envelopment has brought the Germans the prize they sought, and though the more recent hardening of the roads by frost is bound to facilitate panzer attacks, there seems no reason to suppose that the enemy will secure their objective this end of the winter. Neither have they overcome the Leningrad defences. Only in the south, where the weather has been milder, have they continued to make headway in their drive to the Caucasus. They forced the narrow entry into the Crimea by means of mass attacks with artillery and dive bombers and have set siege to Sevastopol in the south, while at the same time they have forced the Russians to evacuate Kerch at the narrow entrance to the Sea of Azov. Across this entrance lies a short cut to the Caucasus, and Russian tactics will probably concentrate on barring the way by means of forces massed on the Caucasus side. Rostov at the north eastern head of the Sea of Azov remains still in Russian hands and here further defences based on the line of the river Don may be expected to operate.

It is probable that the German line of strategy during the winter will aim at getting as near to the oilfields as they can, with a view to more decisive action in the Spring. The main oil centres in the Caucasus are at Baku (75 per cent. of the total), behind lofty mountains which should be an effective barrier in winter; and at Maikop and Grozny on the northern side of those mountains. Maikop lies nearest to the German inroads and will soon be accessible to attacks by Nazi bombers operating from the Crimean aerodromes.[1] Much depends on the strength of the defensive forces which the Russians can oppose, both to attempts to secure a bridgehead across the Kerch straits and to a drive round the Rostov corner and then southwards across the flat territory towards Maikop and Grozny. Ultimately it seems part of the British strategy to oppose the German advance through the Caucasus, since once the enemy secured that area they would gain the entry to all that sphere of Allied influence comprised in Persia, Irak, Syria, and even Egypt. The real tussle may not start before the spring of 1942, and it is clearly the task of General WAVELL, with headquarters in India, to organize the resistance which the British must stage in conjunction with their Russian allies.

At the start of the war German reserves of oil were undoubtedly very great, and till last June consumption could not have been unduly heavy. But since the Russian campaign started five months ago, the drain on the oil supplies must have been very great, and the full acquisition of the Rumanian oil fields (even if they were not permanently damaged by early Russian bombing attacks) cannot possibly supply the German needs. Indications are that the replenishment of their supplies has now become an urgent matter, so the invasion of the Caucasus remains for the Nazis the most important object of their strategy.

Cyrenaica Again.

Since the Germans, by a surprise attack, re-conquered Cyrenaica last April from a British force sadly depleted by the necessity to go to the aid of Greece, and to finish the Abyssinian campaign, the opposing forces in Libya have been dug in on a loose line running from Sollum southwards, each side seemingly marking time while they built up their armies and equipment. In June the British made a major reconnaissance in force to test the enemy's strength and found it too strong; a tank engagement resulting in appreciable losses on both sides. Since then for five months troops, munitions, armoured vehicles and

[1] Maikop does not appear to possess refineries of any importance as distinct from oil wells. Refineries exist at Baku, Batum and Grozny.

aeroplanes have poured into the British headquarters, largely (in the case of the material) from America via the Red Sea route, till a large modern fighting force was established. Meantime, the Germans and Italians have also added to their forces in Africa, but only at the cost of severe losses to the convoys which crossed the Mediterranean. These losses would probably have been severer had the British naval forces had a more adjacent base for their surface vessels ; as it was, the loss of Crete threw the British Navy back on Alexandria and air reconnaissance usually prevented any surprise attacks on the convoys. The bulk of the attacks fell to the submarines, whose achievements were necessarily limited. However, the surface forces of the British Navy did occasionally get a chance and one in November resulted in eight transports being sunk as well as four Italian destroyers.

It was clear in the minds of most observers, that once cooler weather arrived in north Africa, the British forces would be bound to stage a fresh attack on the enemy territory. The need for a second front against the Germans while they were engaged in Russia was obvious, and North Africa seemed the most likely area. The only question was whether larger strategy would dictate a policy of holding the line here, while the bulk of the British middle east armies concentrated on the impending Caucasus campaign. Much depended on what strength in men and equipment was available by now. The uncertainty was ended on November 18th when the British army in Egypt commenced operations in earnest on the Italo-German lines and made a big enveloping drive to the south of the fortified zone at Sollum near the coast. We write too soon after the event to do more than record the initial success of a 100-mile advance into sparsely occupied enemy territory by highly mobile armoured forces. But the main clash with the German Panzer divisions had still to come and that was necessarily the real test. These divisions were massed on the coastal strip and the British tactics comprised an endeavour to outflank them from the desert. By the time these lines are read the world will know whether the British effort has made a success of it or whether they have found the defence too strong to be quickly overcome. Much can happen in fighting of this description in desert territory. Fortified positions are few and far between, and armoured forces if adequately supported in the air can encompass considerable tracts of territory in a short time. Much must depend in this African campaign on the continuing ascendancy of the British air force, and on the extent to which the enemy prove short of supplies, especially of oil. It is the first time in the war, also, that the British are able to oppose German fighting technique with like tactics and with equal assembly of men and armaments. The results may consequently have a material bearing on the duration of the war.

Another American Step.

Since the passing of the Lease-Lend Act last summer the United States has taken no more important step in its support of the Allies than the action of Congress last month in finally deciding to repeal certain technical provisions of the Neutrality Act and permit the arming of American merchant ships and the lifting of the ban on their entry into war zones and belligerent ports. This is the answer to the undeclared war which Germany is carrying on against America and necessarily involves an undeclared war on America's part. It takes up the challenge of HITLER who claims to forbid the presence of U.S. ships in any area he choses to call a war zone and to sink at sight any offenders whether carrying contraband or not. The practical effect of the decision is that from now onwards American ships will be free as circumstances dictate to voyage the whole journey to British and other Allied ports with the armaments and food which the United States have decided to deliver to those fighting against Hitlerism. And these ships will be armed to resist such opposition as the enemy may offer to their passage. The number of ships at the start may not be great ; it has been put in America at some three a week to begin with, which is the present construction rate in that big country. Next year that rate will be stepped up to one a day, but in any event American ships will go where they are most needed to help the cause, and the north Atlantic is not the only zone that calls for their services. In any event, the latter will be of tremendous help to the Allied cause.

This decision of Congress was not achieved by a majority that might be assumed to represent the state of public opinion towards the war effort. Actually, it was only passed by the House of Representatives by 214 votes to 194—a majority of 18, and the 214 in favour included 22 Republicans, while the minority included 53 of the President's own party. Numerous cross currents affected the voting. The traditional conflict between the Executive and the Legislature was, as is usual in such debates, much in evidence. In the United States parties are never prone to vote blindly for their own leader's policy and will rebel to accentuate some important side issue ; and in this case the adverse voting was some measure of a strong feeling that the trade unions in the big industries on which armaments production relies for supplies were being allowed too much scope to air their sectional grievances by means of strikes, and that the President was not taking as strong a line with the malcontents as the serious situation justified. Admittedly, American trade unionism is not, as yet, organized on rational lines, such as is the case in the United Kingdom, and the leaders of the movement are still fighting for a degree of recognition which the employers so far have been disinclined to concede. But both employers and workers have still some way to go to realize what is at stake

for their country in this war, and time will be required to stress the need to sink internal differences of industrial policy in favour of the national effort to avert a much larger danger to the whole community. This stage of transition seems inevitable in a democratic country, and the political history of the United Kingdom during the first few months of actual war doubtless supplies parallels of like difficulties.

In any event the American Executive has need to walk warily in these immediate days, since an open war in the Atlantic is not the only prospect that faces them. The Pacific is also a danger spot and the association of Japan with the Axis is a factor that needs to be handled with caution. Japan apparently has still a loophole of escape from actual participation so long as the United States refrains from declaring war on Germany. But Japan's policy is clearly dictated by opportunism. She is willing to strike to secure her aims, which involve expansion of her territories in the Far East and a general dominance over the whole sphere ; but she knows it is a gamble whether definite aggression against the Powers also interested in that sphere will succeed, so she has persisted with her hesitation, while weighing up from day to day the chances of German victory. American public opinion seems in no mind to give in to Japanese aspirations, and looks like maintaining a firm front in the matter. The next few weeks may see a crisis in that quarter, in which the die will be cast for Japan and she will have to decide one way or another. And the salvation of China is bound up in the result.

British Export Trade in Wartime.

In our last issue we mentioned briefly that the more recent policies of co-operation between the United States Government and the United Kingdom, in particular the provisions of the Lease-Lend agreement, had necessitated a considerable modification in the British export trade policy as devised at the outbreak of the war, and that British goods advertised were no longer necessarily available for export. A more detailed exposition of this change in policy was given in a recent number of the *Times Trade and Engineering* review, and the additional particulars we give below are based on that survey of the position,

On the outbreak of the war, stress was laid in both official and unofficial quarters on the importance during its continuance, of maintaining the prestige and good will of British trade in the export markets of the world. Even if it was impossible to maintain the flow of exports, nothing should be neglected that would keep British goods in view in foreign markets until it was possible to renew the former intercourse. But there was the additional incentive to an export policy that with the large purchases of war materials the British Empire had to make abroad, especially in America, it was clearly necessary by every possible means to stimulate the export trade of the United Kingdom and so facilitate the means to provide dollar exchange for those war purchases. Later on, it became necessary to adopt a more selective policy and exercise discrimination not only with regard to exports that could be spared but also to countries whither those exports should be shipped.

For that purpose a system of Export Groups was instituted by the Government in the first year of the war, whose special function was to confer with the particular groups of industrialists as to the best measures to be adopted to carry out the Government policy in the increasingly difficult circumstances that had arisen. Thereby, the necessary materials were made available for approved classes of exports. Incidentally, one such group was that of our Sugar Machinery Manufacturers, and for the time being they received every encouragement from the Ministry of Supply to export such sugar machinery as they could.

But the position was altered by the passing of the Lease and Lend Act, under which the urgency of securing dollar exchange became less acute because the American Government, in support of the Allies, was thenceforward prepared to supply goods without demanding corresponding cash payment. The value of that action to the Allied cause cannot be over-estimated, but it necessitated a further modification of the British export policy. Naturally the American manufacturer, whose supplies of raw materials were restricted by the operation of the Lease-Lend Act, did not relish the idea that the materials of which he was being deprived might be used to manufacture goods exported from Great Britain and sold in competition with his own. Actually, as the British Embassy in Washington ascertained several months ago, there was no instance known where violation of the letter or spirit of the Lease-Lend Act had occurred. But, it may be gathered, industry had laid its plans months ahead and could not change overnight the course of the export trade, once the Lease-Lend Act was made public. Hence deliveries of goods planned in the days of cash and carry were bound to take place for some time after, and these had been misunderstood and were easily misrepresented.

The British Government, however, lost no time in ensuring that no future violation of the letter or spirit should be possible, and they drew up an agreement with Mr. WINANT, the American Ambassador in London, in respect to exports from this country and the distribution here of lease-lend material. Briefly put, it ensures that lease-lend materials shall not be used for export, and that similar materials will not be supplied to exporters to enable them to enter new markets or extend their export trade at the expense of United States exporters. The U.K. export trade is to be restricted now to the irreducible minimum necessary to supply or obtain materials essential to the war effort.

In short, no materials of a type restricted in the U.S.A. on grounds of short supply and of which we obtain supplies from the States will be used in British exports, save material which is essential to the war effort and cannot be obtained from the U.S.A.; small but essential components of exports composed otherwise of materials not in short supply; and repair parts for British machinery and plant now in use, and machinery and plant needed to complete installations now under construction, so long as they have already been contracted for. Steps have been taken to prevent the export (except to Empire and Allied territories) of such goods as do not come within the above exceptions; and materials similar to those not in short supply in the U.S.A. will not be used for export in quantities greater than those we ourselves produce or buy from any source.

As regards the sugar machinery industry, it may be said that sugar being recognised by the authorities as a wartime necessity, a quota of material, though strictly limited, continues to be allotted by the Government for the manufacture of the spare parts essential for maintaining existing sugar factories in production. To that extent demands from overseas can be met.

The *Times*, in the course of reviewing these changes of wartime export policy, observed that one thing is clear and "that is that after the war the future of this country will depend on its overseas trade at least as much as it did before hostilities broke out." So it remains vitally important to maintain meantime the prestige of British goods and keep them in memory in foreign markets. The export journal and the advertising page still have their parts to play even in these days when the exigencies of the war may prevent any immediate response from the potential buyer being accepted. The time for that acceptance will be in the post-war years. Till that time (to quote our contemporary again) "the less it is possible to sell the more it becomes necessary to advertise.... The day to abandon advertising will be the day when hope of regaining our commercial prosperity has fled; at present that day is as distant as the Greek kalends."

West Indies Sugar Company.

At the fourth annual general meeting of the West Indies Sugar Co. Ltd., the chairman (Sir Leonard Lyle, M.P.) referred to the improved social conditions which they were helping to establish in Jamaica where their factory was situated. Within the limit of their means they have done much to improve the conditions of their employees and have striven to cultivate a better understanding amongst them with a view to developing a spirit of co-operation. Notable strides have been made in the sphere of social and welfare work for the betterment of conditions. Some independent testimony to this was recently provided in a letter to the local *Gleaner*, whose writer spoke approvingly of the Company's co-operation with native social development schemes, as a consequence of which much charitable work had been undertaken. This had done much to erase the line of demarcation between employee and employer. The practical social work of this big concern was evident to any one who visited Frome, which estate contrasted with the adjoining districts or with the former sugar areas.

Sir Leonard observed that, in his view, the most urgent attention of the Government should be directed to well-planned housing schemes, more especially in the rural areas of Jamaica. Estates proprietors obviously cannot be expected to provide housing accommodation for all workpeople who find employment on the estates. He was in favour of housing those people who were in full daily employment and who needed to live in the vicinity of their work; but the vast majority of those workpeople who depend for a livelihood upon the estates do not fall within this category, and to better their conditions was surely a duty which devolved on the local Government.

The output of the Frome factory for 1941 was 51,268 tons of sugar, which is easily a record for this new factory and compares with 32,347 tons in 1940. As regards prices, the existing plan with the Sugar Control necessitates agreeing a price for the sugar one year in advance of production. This unfortunately puts the company in the position of having to absorb practically all further increases in cost of labour and materials without any compensation from an increased price. The world free market price has appreciated considerably within recent weeks, indeed has risen higher than the parity on which their 1942 price is based. Colonial sugar producers are anxious to see the Mother Country assured of ample sugar supplies at reasonable prices, but at the same time it is only fair for them to expect in return some insulation against rising costs over which they have no control.

Plastics from Bagasse.

By the word "plastics" one understands materials which are capable of being moulded under the influence of heat and pressure into articles which take the place of those formerly generally made of metal, wood, glass, porcelain; such as ash-trays, electrical fittings, lenses, cups and saucers, and the like. Plastics can be cut, turned and polished like wood and metal. Depending upon the ingredients from which they have been compounded, they may be dark-coloured, mottled, brightly coloured, or transparent. They are broadly classified as "thermo-plastic" and "thermo-setting," the first being of the type which can be softened and re-softened repeatedly by heat and pressure, while the second includes those which once subjected to heat and pressure can be moulded only once, refusing to be re-formed by further heat and pressure.

In the present issue will be found evidence of the fact that plastics can now be produced from bagasse.[1] Work carried out by the U.S. Department of Agriculture, at the Agricultural By-products Laboratory, Ames, Iowa, and by Valentine Sugars, Inc., of Lockport, La., U.S.A., has shown that after the cellulose of bagasse has been destroyed or transformed by suitable chemical means, and certain impurities eliminated by washing out, there remains behind the substance lignin, which by treatment with furfural can be converted into a moulding powder. It gives plastics of the thermo-setting type, though they exhibit some thermo-plastic characteristics.

In appearance the material obtained is lustrous black. It has great strength and resistance to moisture absorption. It adheres well to metal. Automobile steering wheels made of it have successfully passed stringent laboratory tests. It is oil-resistant. Further, it is said to have satisfactory electrical properties, comparable in fact with those of the phenol-formaldehyde (Bakelite) and phenol-furfural plastics. It is likely also to find use in the building and furniture trades. It is early yet to offer any prediction as to what the future of lignin-furfural plastics produced from bagasse may be until large scale production has given some more certain indication of costs than can be obtained from laboratory and pilot plant tests.

However, the prospects of its producing an economic rival to materials at present in use are very hopeful, especially if the acid hydrolysis process were used for the transformation of the cellulose content of the bagasse, and also if the hydrolysed by-product containing sugars were converted into commercial alcohol. Another possible economy might be the production of the furfural from the bagasse pith on the spot in the lignin-extracting factory. This "Plastics from Bagasse" project is a development which will be watched with no little interest as a possibly profitable means of utilizing the bagasse, and especially surplus bagasse, of the cane sugar factory.

The Sugar Cane in India.

Proceedings of Ninth Annual Convention, Sugar Technologists' Association of India, 1940.

This Meeting held its sessions at Cawnpore and not unnaturally, therefore, a considerable portion of the proceedings is devoted to the problems which exercize the minds of the investigators of the United Provinces.

One of the more important problems discussed concerned the deterioration which had characterized the crop in the Doab, lying between the Ganges and Jumna and embracing the important sugar growing tracts of Meerut and Mozuffarnagar, in the season 1937-38. This deterioration was so marked that a committee of investigation was appointed. One of the papers presented to the Convention by R. N. Mathur and B. D. Gupta embodies the conclusions based on a survey of the tract in question. The map attached to the paper indicates that, based on the severity of the deterioration, the tract is divisible into four sections; the first, roughly triangular with its base on the Ganges and the westerly apex at Meerut; the second, a belt embracing this triangle with its two extremities based on the Ganges; the fourth a western belt of approximately equal breadth bounded on the West by the Jumna and the third occupying the intervening area between the two latter. Some measure of the deterioration experienced is given by the sugar recoveries of factories situated in these four sections. In the first, recoveries ranged from 8·37 to 8·55 per cent.; in the second from 7·89 to 8·39 per cent.; in the third, 7·77 per cent, and in the fourth from 4·25 to 5·81 per cent. Similarly, losses in gur manufacture ranged from some 10 to 75 per cent. in passing from East to West.

The most striking fact resulting from the survey is that corresponding to this deterioration in passing from East to West is a growing intensity of attack by *pyrilla*. Confirmation is given to the conclusion by a reference to the year 1934-35 which was characterized by a severe attack of *pyrilla* when recoveries varied between 5·0 and 7·1 per cent.

As to the nature of the damage caused by the pest, it is noted that, besides injury due to sucking, the insect deposits an appreciable quantity of an optically active substance, probably of the nature of an amino-acid on the leaves, a substance which is a precursor of sugar in the leaf. The incrustations may also diminish the assimilatory capacity of the leaves.

The conditions which favour the attack by *pyrilla* are easterly winds with high humidity during the pre-monsoon period and periods of drought during the monsoon. Other features disclosed are higher intensity in fields with vigorous growth, in the more succulent and leafy plant cane, in the interior of the field and in fields bordering ratoons, while Co 313 suffers less than Co 312, Co 244 and Co 213. Un-

[1] See pp. 371-3.

fortunately, the absence of adequate meteorological records prevents any detailed study of the conditions actually prevailing during the years of severe attack. It is unfortunate, too, that the higher standard of cultivation which characterizes the *Jat* cultivator, exposes him to the greatest risk of damage.

The results obtained from physiological studies of the sugar cane at Shahjahanpur during the preceding five years are described by R. N. MATHUR and I. U. HAIDER. In the main, these are studies which are normally classified as agricultural. Such a series, commenced in 1934 and repeated in successive years, deals with the inter-relationship between nitrogen fertilization and water duty, to which two factors, first a date of planting and, later, a variety factor, were added. The nitrogen levels adopted were 0, 100 and 200 lbs. per acre as sulphate and the water levels 240, 360, 540 and 960 thousand gallons per acre, successive years showing a selection of the above values. Dates of planting corresponded to early (February 1), mid-season (March 8) and late (April 12). The varieties involved and introduced into the trials during the last year (1938-39) only, were Co 313 (early), Co 421 (mid-season) and Co 331 (late maturing). The rainfall varied widely, being 38·04 in. in 1934, 25·75 in. in 1935, 70·23 in. in 1936, 22·78 in. in 1937 and 39·43 in. in 1938. The general reaction of the plant is for the maximum weight of cane to occur early (about Feb. 5); this is followed by a minimum of reducing sugars (about Feb. 26) and a maximum of sucrose (about March 26). In the matter of reaping, therefore, when payment is by weight of cane, the factory and cultivator's interests are not identical. The response to 100 lbs. nitrogen was marked, with a further, but not proprotional increase from 200 lbs. The practical conclusion, however, is that the interaction between nitrogen and water is such that heavy dressings of the former without heavy irrigation are useless and *vice versa*; and it is pointed out that the flat rate charged for the crop under canal irrigation is unsatisfactory in that it tends to drive the cultivator to flood his crop whenever possible without regard to the nitrogen status. In 1936, the year of excessive rainfall, when the maximum of 960 thousand gallons, the equivalent of 12 irrigations, was included in the programme, this maximum lowered the sugar appreciably where no nitrogen was applied but, where 200 lbs. was given, the 12 irrigations gave more sugar than either three or six.

As a general rule early planting showed poorer germination than later plantings, though not invariably so, and, in most cases, loss on this account is made good by increased tillering and efficient use of nitrogen and water.

In 1937 the crops generally were the subject of attack by *pyrilla* the effect of which was to reduce the amount of sucrose in the earlier sown crops with their greater vegetative growth and leaf development. The effect of this attack was carried into the following year, 1938, when a varietal factor was introduced, and appeared as low germination in the early sown crops. This was most marked in Co 313, the germination of which in the later sown crops remained relatively poor though it shared in the general recovery. Only in the late sown crop, consequently, did the relatively high sucrose content of the juice of Co 313 result in the highest yield of sugar per acre.

The inter-relation between nitrogen and spacing is briefly noted. In 1936-37, with a low nitrogen level maximum yields resulted from some 8000 plants per acre and shifted to 6000 plants per acre when 100 lbs. nitrogen was applied. The following year, however, for all levels of nitrogen the highest yield resulted from 11,000 plants per acre.

The importance of using good seed material for planting and the effect of pre-treatment with water alone and with lime wash was discussed by R. N. MATHUR. By comparing sets taken from crops grown on high nitrogen and water levels (good) and on low levels of these (poor) he shows that quality is something more than selection of disease-free stalks. Increases in germination varying from 7 to 20 per cent. resulted from the use of good material while increases in yield of sugar ranging from 10 to 40 per cent. were obtained, with the maximum increase in the mid-season crop. The effect of pre-treatment is clearly shown to be beneficial but the results lack a concordance sufficient to discriminate between the two treatments.

A further suggested method of reducing costs of production is to dismantle the ridges prior to cutting and to cut the cane so as to include the exposed portion of the stalk. Figures are given to show that the yield of cane is thereby increased by 5·8 per cent. containing 7·62 per cent. available sugar, an addition of some 5 per cent. on the yield of sugar.

L. B. PAUL attributes the rise of the sugar industry to importance to the protection given in 1931 and suggests that a depression will set in when that protection is withdrawn unless the yield of sugar is raised by improved methods of cultivation. This conclusive need is undoubted but it is doubtful if the fact that Java produces five times more sugar per acre than India is not too great a simplification of the question since it neglects the costs of production. The paper contains a tabulated statement of the performance of a number of Co canes in Bengal.

H. M. L.

BRITISH BEET CROP, 1941.—Some further official light on the condition of the United Kingdom sugar beet crop of 1941 was vouchsafed last month when the Minister of Agriculture told the House of Commons that the crop was greater than was originally expected, but it would probably be below the average both in tonnage and in sugar content. It is understood that next year the aim is to produce if possible sufficient beet to work the existing factories to full capacity.

The Sugar Cane in Hawaii.

Experiment Station Committee Report, 1940.

ENTOMOLOGY (*C. E. Pemberton*).

The position with regard to pests in the year ending 30th September, 1940, is noted as having been generally satisfactory with the appearance of no new insects and little change in the status of those already recorded. Detailed information concerning the major pests may be summed up as follows :—

Cane Root Grub (*Anomala orientalis*). A slight spread to new areas is recorded but the infestation was light and accompanied by the two parasites, *Campsomeris marginella modesta* and *Tiphia segregata*. The latter was introduced from the Philippines in 1917 and remained scarce till 1934, since which date it appears to have become better and better adapted to its new environment. This observation is of interest in view of the opinion somewhat widely held that if a hyperparasite fails to establish itself in the first two or three years, there is little prospect of ultimate success.

Cane Borer (*Rhabdocnemis obscura*). Damage from this pest has been generally light and the parasite, *Microceromasia sphenophori*, has exercised effective control. The predatory beetle, an enemy of the borer, *Dactylosternum hydrophiloides* was found established at Honokaa where it had been liberated on its introduction from the Philippines in 1925. It would appear to offer another example of delayed adaptation.

Army worm (*Laphygma exempta*). Numerous infestations occurred but these were not so extensive or prolonged as in the previous year. The cause for this diminution is tentatively attributed to the large scale release of the egg parasite, *Telenomus nawai*. Among other controls which have proved very effective at times is mentioned the Mexican parasite, *Euplectrus platyhyphenae*. The cause of the sudden disappearance of the army worm, which sometimes occurs without adequate abundance of parasites, has been sought in the effect of relative humidity on the eggs and of silica content of the leaves but without conclusive results.

Argentine Ant (*Iridomyrmex humilis*). This ant, which is described as an unmitigated nuisance in the South-eastern States and California where it first appeared in 1891, has been found in large numbers in Honolulu. It is aggressive in habit and indirectly injurious by fostering mealybugs and plant lice and by interfering with the work of beneficial insects.

Quarantine.—Emphasis is laid on quarantine through the recently established trans-pacific air lines. All planes are inspected and treated with insecticides at either Midway or Canton Islands. For the same reason, surveys have been made of the pests found in New Caledonia, Guam[1] and Samoa.[1]

PATHOLOGY (*J. P. Martin*).

Foreign Cane Diseases.—The year records for the first time the presence of Fiji disease in New Caledonia, the vector of which is *Perkinsellia sp.* This disease, thus, comes within the purview of the quarantine service as noted in the preceding paragraph.

Something in the nature of international cooperation has been established with Queensland where Hawaiian varieties are being tested for resistance to the major diseases of that southern country. The variety 31-1389 appears to be highly resistant to gumming disease but quite susceptible to downy mildew. Other varieties which have been sent to Queensland and which will be tested on release from quarantine are 28-4291, 31-2484, 31-2806, 32-1063, 32-3575 and 32-8560.

Hawaiian Cane Diseases.—With growing economic stress in the industry, all means of reducing losses have to be employed and a plantation inspection service is maintained, one function of which is to aid the plantation in the effective application of those minimizing measures which must be conducted by the local staff. For the assistance of these, the main measures are listed as plant resistant varieties; plant only healthy material; rogue diseased plants, especially in areas from which seed cane is to be drawn; maintain favourable growing conditions; sterilize cane knives and subject cane cuttings to the hot water treatment (20 minutes at 52°C.) for controlling chlorotic streak. As a guide to selection of the most suitable variety a table of tolerance of the main commercial canes to the major diseases is given and is reproduced here. The investigations into the main diseases are reviewed.

Brown Stripe.—The disease is localized on Oahu and Kauai. Earlier information as to varietal tolerance remains unaltered.

Chlorisis, Banded.—This results from low temperatures and may be artificially produced by ice-pack round the central spindle. Recently, however, it has arisen as the result of exposure to a temperature of 130°F. for five hours.

Chlorotic Streak.—Measurements of the losses resulting from this disease were determined by a comparison of the crops from (a) healthy (b) diseased and (c) diseased, hot water treated sets. The diseased-treated crop surpassed the diseased crop by 15·5 tons cane and 1·5 tons sugar and the healthy crop by 4·3 tons cane and 0·1 tons sugar. The first of these results is highly significant, the latter not significant; a clear indication of the value of the hot water treatment. The variety concerned was 31-2806. The nature of the disease has yet to be determined

[1] *I.S.J.*, 1941, p. 311 and 312.

VARIETIES AND THEIR TOLERANCE TO THE MAJOR CANE DISEASES.*

	Eye Spot.	Brown Stripe.	Leaf Scald.	Chlorotic Streak.	Mosaic.	Pythium Root Rot.
H 109	2	2	4	5	4	6
Yel. Cal.	6	3	3	4	6	6
D 1135	5	3	6	5	6	6
POJ 36	4	3	7	4	7	6
POJ 2878	3	3	7	3	7	6
Str. Tip	5	5	5	–	2	–
Yel. Tip	5	5	3	–	2	–
Badila	6	5	3	–	6	6
UD 50	6	–	3	–	6	–
UD 1	2	2	–	–	6	–
Kohala 202	5	5	6	–	3	–
Uba (Hawaiian)	7	5	6	–	6	6
26 Q 2873	3	5	6	–	6	–
H 8965	3	3	3	–	4	6
27-8101	6	4	6	–	6	6
28-1234	3	5	6	–	6	–
28-1813	3	5	6	–	6	–
28-1864	2	6	–	–	6	–
28-2055	5	5	6	–	6	6
28-3540	6	3	6	–	6	–
28-4291	6	5	2	–	6	6
29-3859	5	5	2	–	6	–
31-1203	2	5	–	–	6	–
31-1389	7	2	5	4	7	6
31-2484	6	4	–	5	6	–
31-2510	6	6	3	–	6	6
31-2538	3	5	–	–	1	6
31-2806	4	5	6	2	6	6
31-3243	6	5	–	–	6	–
32-256	6	3	2	–	6	–
32-1063	6	5	6	5	6	6
32-3575	6	5	6	–	6	–
32-8560	6	5	6	5	6	6
33-2690	3	3	6	2	6	6

7 Very highly resistant.
6 Highly resistant.
5 Moderately resistant.
4 Average.
3 Moderately susceptible.
2 Highly susceptible.
1 Very highly susceptible.

*For convenience of setting, we have substituted number values in this table in place of the symbols used in the original.—ED. *I.S.J.*

with certainty. As has been previously noted,[1] an intracellular Chytrid has been found associated with the disease and a similar organism has been reported on elephant grass (*Pennisetum purpureum*) which, with Job's tears (*Coix lachryma Jobi*), shows symptoms similar to those of chlorotic streak. It is noted, too, that, for the first time, the disease has been artificially transmitted to healthy plants of POJ 2878 and 31-2806 (very susceptible varieties) by hypodermic inoculation near the growing point with a plant extract obtained from diseased cane as well as with two waters (ditch and surface) from a locality where chlorotic streak was common. It would seem possible that the disease may occur in soil extracts.

Eye Spot.—Apart from the varietal tolerance trials, a new technique for the inoculation of cane leaves with the spores of *Helminthosporium sacchari* is noted. Leaves of uniform age are laid in several layers of moistened cloth, sprayed on their upper and lower surfaces with spores, covered with several more layers of moistened cloth and, finally, a layer of wax paper spread over all. The leaves remain fresh for two weeks, a sufficient period for the fungus to spread and develop new spores.

Leaf Scald.—Environmental conditions play an important rôle in determining the severity of the attack and an outbreak at Puna, Hawaii, was definitely associated with very dry weather preceding and during the summer months. Here, where the disease has always been severe in periods of drought, an acre each of 32-8560 and 32-1063 are being planted. Leaf scald has not been observed on either while the former is, additionally, highly drought resistant. Meanwhile avoidance of transmission by cane knives is the major control associated with planting disease-free material.

Stem Galls.—Four canes of POJ 2878 inoculated with surface water (as noted above) developed typical stem galls, hypertrophies which are capable of making further growth and may develop adventitious buds. Like galls have also resulted from inoculations with Kailua soil extract and with an extract prepared from the green leaf-hopper, *Draeculacephala mollipes*.

Mosaic.—Of the ten or more recognized strains, that present in Hawaii has a very low virulence. Precautionary quarantine measures are required to assure the exclusion of the more virulent strains whether by cane, grasses or carriers. Meanwhile, the disease is kept within control by the plantation measures of using resistant varieties, planting healthy sets, controlling weeds and roguing.

Red Rot.—The disease appears to be on the increase, a fact which is of especial concern in respect to promising new varieties. The variety 33-2690 has shown considerable dead cane at harvest in the wetter districts as the result of attack by the causative organism, *Colletotrichum falcatum*. The variety 33-4701 has also been found attacked on different islands with, on Oahu, some 30 to 40 per cent. dead cane and 60 to 70 per cent. of the remainder affected. Inoculation experiments showed this variety to be extremely susceptible and the discontinuance of its distribution is recommended in consequence. The organism gains entrance through mechanical injuries and the damage is not limited to the dead cane; it may attack cane stubble, leading to weak ratoons, or cane sets, leading to poor germination.

Physiological Disorders.—In studying the effect of excess supply of a number of elements it was found that high boron, nitrogen, phosphorus and, to some extent, manganese had a depressing effect on cane juices while high magnesium and iron were beneficial as was the combination high magnesium-low calcium. Ten-week old cuttings grown in nutrient solutions deficient in one of a series of elements gave the following results recorded in days till the deficiency effect became apparent: nitrogen, 8 days; iron and boron, 12 days; magnesium calcium and sulphur, 22 days.

(*To be continued*).

[1] *I.S.J.*, 1941, p. 44.

Power Alcohol Production in Australia.

Report of a Committee of Inquiry.

In August, 1940, the Australian Commonwealth Government appointed a Committee to inquire into and report upon the utilization of farm and/or forest products and by-products for the increased production of Power Alcohol. Its personnel included not only representatives of Government Departments, but also two representatives from the sugar industry, namely, Dr. R. W. HARMAN (C.S.R. Co. Ltd.) and Mr. R. MUIR (of the Queensland Cane Growers' Council). The Report of the Committee was issued in May, 1941,[1] and we give below a summary of some of the evidence tendered and the conclusions arrived at. In its enquiries, the Committee studied a great volume of literature and consulted all official and non-official authorities known to be in possession of relevant information ; and public hearings were held in Brisbane, Sydney and Melbourne, amongst other places.

Outline of Evidence.—Detailed statements were submitted by the Queensland Government and jointly by the Australian Sugar Producers' Association and the Queensland Cane Growers' Association. Evidence obtained in Queensland naturally referred to the use of sugar cane products as the raw material for alcohol production. At present, all the power alcohol produced in Australia comes from molasses. The main problems in Queensland arise from proposals to use cane products that could otherwise be used to produce crystallized sugar. The evidence tendered contained no specific proposals for the use of sugar as a source of alcohol, but it conveyed that both the Queensland Government and the sugar industry would look favourably upon alcohol production from sugar, provided that the organization of the industry were not disturbed, and sugar producers were assured of a fair return. Evidence was also taken for the use, as a source of alcohol, of Wheat, Wood, Grapes and some other crops, such as Nipa and Sago Palms.

Power Alcohol Production.—For strategic reasons, and in view of the possible depletion of petroleum resources, there is world-wide interest in such substitute fuels as petrol (gasoline) from coal and shale, power alcohol, benzol, charcoal producer gas and coal gas. Anhydrous ethyl alcohol may be manufactured from sugary, starchy or cellulosic materials. As power alcohol, it is most commonly used in 12½ to 20 per cent. blends with petrol. The world production of power alcohol approximates to 200 million gallons, distributed amongst some dozen countries,[2] in most of which, where such alcohol is made, there is legislation to enforce its use, owing to the higher price of alcohol as compared with petrol. In Australia anhydrous alcohol for use as motor fuel has been produced since 1925, though only recently to an extent exceeding a million gallons per annum. The existing power alcohol distilleries have at present a normal capacity of five million gallons per annum, but owing to shortage of raw material (molasses) they have not worked hitherto at full capacity. But it is estimated that there is, in addition, suitable distillery capacity in Australia for another five million gallons of 95 per cent. alcohol.

The process of manufacturing anhydrous alcohol from sugar substances comprises (*a*) fermentation by yeast to produce a liquid containing 10 per cent. alcohol and (*b*) distillation of the fermented liquor and dehydration by a patented process. Starchy substances must first be treated by malting, hydrolysis with acid, or the action of moulds (amylo process) to break the starch down to sugar. Subsequent fermentation and distillation are much the same as for sugary substances. Cellulosic substances (e.g., wood) may be converted to sugar by two processes, both involving the action of acid on wood.

Alcohol containing water is unsatisfactory as a motor fuel unless considerable quantities of blending agents besides petrol are added. But there is ample evidence that alcohol-petrol blends in the proportions of 12½ to 20 per cent. of anhydrous alcohol with petrol possess all the properties desirable as a motor fuel and that there is no measurable difference as between a 15 per cent. alcohol-petrol blend and other super fuels in mileage per gallon and in other criteria of performance. The addition of 1 per cent. of alcohol to petrol raises the octane rating by about 0·6 unit. A higher octane rating over that of standard grade petrol is desirable for many modern cars, and is likely to increase in importance as engine design changes.

As regards transport of alcohol, technical difficulties involved in its carriage in drums or in road or rail tanks have been overcome ; but there is no experience of the transport of large quantities of anhydrous alcohol in tanker ships. The chief technical difficulty is to avoid absorption of water and the effect of the inward leakage of sea water into tankers would have to be overcome before alcohol could be successfully transported by sea in bulk.

As in most countries excise duties are levied on alcoholic beverages but not on alcohol used for industrial purposes, the question of denaturants for the latter has always to be faced. Power alcohol may be denatured as for mineralized spirits, i.e., by adding 0·25 per cent. methyl alcohol, 0·05 per cent. pyridine and 2 per cent. petrol. A more suitable denaturation,

1 "Report of the Power Alcohol Committee of Inquiry. 17th May, 1941." (Issued by Commonwealth Government Printer Canberra, Australia). 2 That is, in Germany, France, England, Italy, Austria, Hungary, Czechoslovakia, Sweden, Japan, Brazil, Philippines and Australia.

for use only under security to the Customs Dept., is 0·25 per cent. methyl alcohol and 5 per cent. petrol.

Proposed Practice covering Sugar.—From a survey of the present position of the sugar industry in Queensland it is concluded that—(*a*) the average price of cane as sold to the mill owner is about 32s. per ton ; (*b*) the home consumption price of raw sugar is approximately £23. 10s. 0d. per ton ; and (*c*) the export price has varied from about £8 per ton (pre-war) to about £11 per ton in 1941. The average price of home and export sugar together is about £15. 10s. 0d. per ton.

In 1940 over 50 per cent. of Queensland molasses was sold to distilleries ; this percentage is expected to rise to approximately 75 in 1941. The usual price for the molasses is 15s. per ton at the mill. In 1940 the output of power alcohol from this source was some two million gallons, but in 1941 it is expected that production will increase to 3½ to 4 million gallons. But beyond that no further significant increase in power alcohol production from molasses can be expected.

After examining several schemes whereby sugar might be diverted during manufacture to supply a raw material for alcohol production, the Committee considers that a "juice mill" scheme would be more satisfactory than the other schemes it examined. This scheme envisages a large distillery alongside a sugar mill, the whole of the sugar product from, say, 250,000 tons of cane being turned into alcohol. The cane would be treated as for sugar up to the clarified juice stage and this juice then be delivered to the distillery. Under this plan, an operating period of some 30 weeks per year could be allowed, which is about five weeks longer than the normal raw sugar manufacturing period. Assuming 20 gallons of alcohol per ton of cane, such a distillery would yield five million gallons of alcohol per annum in 30 weeks. Its capital cost is put at £550,000. Exclusive of raw material, the total manufacturing cost of the product, from clarified juice to alcohol in the storage tanks, has been estimated at 7·13d. per gallon.

Another plan considered was the "B. Syrup Scheme," under which a number of small distilleries would be built alongside existing sugar mills and produce power alcohol from "B. syrup" taken from those mills, that is the syrup which undergoes the fourth and last crystallization and contains the total mill output of final molasses plus a proportion of the recoverable sugar varying from 5 to 10 per cent. of the total output. A typical distillery of this type would require a capacity of half a million gallons of alcohol in a normal sugar working season, to deal with the total output of molasses plus 6 per cent. or so of the raw sugar output. Not all sugar mills would find this scheme suitable or desirable. But if all 33 Queensland mills could enter into a B. syrup scheme, the total extra alcohol from recoverable sugar would be about five million gallons.

Taking the "Juice mill" scheme, if it were agreed that a price of £7. 9s. 0d. at mill per ton of 94 net titre sugar and corresponding molasses, both in the form of a clarified juice, were to be paid (approximately equivalent to about £9 per ton 94 n.t. sugar, f.o b Port), then the alcohol could be sold in a capital city at 2s. per gallon wholesale. Each million gallons of alcohol produced from sugar cane would absorb about 50,000 tons of cane or say 8,000 tons of sugar.

Financial Considerations. — Australia's normal peace-time requirements of motor fuel are at least 350 million gallons. If all this were to be a 15 per cent. alcohol blend, the alcohol required would amount to 52,500,000 gallons. Assuming the wholesale price of the alcohol is 2s., the total extra cost of producing all this alcohol would be £3,142,000, or an increase, say, of 2·15d. (made up of 1·69d. for revenue and 0·46d. for extra cost of alcohol) in the price of a gallon of fuel. This sum is reduced to 1·65d. after allowance is made for the value received from the use of alcohol blend as a super fuel, since 50 per cent. of consumers are willing to pay 1d. per gallon more for this grade.

Conclusions Drawn.—Alcohol, to be used for blending, has a value in excess of that of an equal volume of standard potrol, by reason of its power to raise a standard grade fuel to super grade. Maximum benefits are obtained with a 15 per cent. alcohol blend, and the Committee considers that alcohol should be used in this percentage and the blend marketed through established distribution channels under distinctive names indicating the presence of alcohol.

The three existing power alcohol distilleries in Australia, if using the raw sugar to supplement the molasses, could produce up to 7 million gallons of alcohol annually. On the basis of an annual total requirement of 52 million gallons, production from new distilleries of a total annual capacity of 45½ million gallons of anhydrous alcohol could be absorbed. No recommendation is made as to the distribution of distilleries between wheat and sugar, but one possible distribution discussed was 38 million gallons from wheat and 7½ million gallons from sugar, which would use up about 15 per cent. of the normal exportable quantities of the two products.

Although the cost of power alcohol is considerably higher than that of imported petrol, there are important national and social advantages to offset this. Two main ones are : (1) defence value and (2) stabilization of agriculture. At the moment the defence value is paramount and fully justifies expansion. But the stabilizing effect of the industry on agriculture, by providing a home market for some proportion of the unexportable wheat and sugar, is considered important enough to justify considerable extension of the alcohol industry. There is no intention to encourage the production of wheat and sugar above present levels to supply material for

power alcohol[1]; on the contrary, the raw material must come from present production outputs, or else stabilization would not be effected.

Committee's Recommendations.—The Inquiry Committee recommended that immediate action should be taken to erect distilleries to produce 40½ million gallons of anhydrous alcohol per annum. If 95 per cent. alcohol should prove unsuitable or unprocurable as a motor fuel, the figure should be raised to 45½ million gallons. These distilleries should use wheat and sugar cane products in proportions having regard to strategic considerations, the proportions of surplus wheat and sugar, each State's requirements of fuel, and the time needed to erect the distilleries.

The selling price of power alcohol, wholesale at capital cities, should be 2s. per gallon, which in the case of sugar products is expected to give a price of about £9 per ton 94 n.t. sugar f.o.b. Queensland ports. The sites of the distilleries should be decided by strategic considerations, location of raw material, and fuel distributing centres. They should be owned by the Commonwealth, which should also control, preferably by legislation, the blending and sale of the alcohol produced. A period of five years is recommended for the experiment before coming to any decision whether to continue or suspend the operation of the distilleries.

***Owing to mail and other delays, this Report of the Committee of Enquiry came to hand about two months after we had received particulars (which we published in our October issue, page 294) of the intention of the Federal Government to implement the recommendations to some extent. As a first objective they propose the production of 22 million gallons per annum, 7 millions to come from the existing anhydrous distilleries, 5 millions from existing rectified spirit distilleries, and 10 millions from new distilleries to be erected, using exclusively wheat as the raw material.—ED., *I.S.J.*

U.S.A. Sugar Industry at September, 1941.[2]

The change in outlook in the United States from one of surplus sugar supplies to a closer balance invites an analysis of the position and a recent Department of Commerce brochure sums up the statistical data. The need of obtaining increased supplies of sugar seems clearly indicated and warrants the recent augmentations of the quota. The mainstay of supply, Cuba, has recently allocated larger quantities of sugar to extra-American destinations than was earlier anticipated, and so stocks of sugar in Cuba will be considerably lower at the end of 1941 than was expected some months ago.

Demand.—Deliveries of sugar to U.S.A. manufacturers, wholesalers and retailers during the first eight months of 1941 were roughly 25 per cent. higher than during the corresponding period of 1940 but the rate was not expected to be maintained during the balance of the year. Total deliveries for 1941 are estimated at about 8 million tons, or 16⅔ per cent. more than in 1940. Fear of price rises may have prompted some of the buying ahead, but the main reason for the change in purchasing policy was the insurance of adequate supplies of sugar for manufacturing. Consumer hoarding accounts for part of the demand, but assuming 2,000,000 families bought each 100 lbs. of sugar, this would only absorb 100,000 tons. Retail store stocks are limited, for obvious reasons, and as wholesale price rises are surely passed on, there is no real need for wholesalers to buy in fear of a price rise.

Total deliveries, January to August, were 5,565,000 short tons, of which 3,742,000 tons (against 2,845 tons in 1940) came from the refiners, 1,356,000 tons (against 1,046,000) from beet processors, 430,000 tons (against 532,000) from importers and 237,000 tons (against 56,000) from mainland cane factories. The total in 1940 was 4,479,000 tons. As compared with 1940, this year represents an increase of 24 per cent. Total stocks at August 1st were 1,739,000 tons, as compared with 1,737,000 tons in 1940 (same date).

Supply.—Provided ships are available, particularly from Cuba, and no increase in forward buying develops, there should be sufficient sugar for the remaining four months of 1941. Cane sugar refiners should have available 1,500,000 tons from off-shore areas plus 250,000 tons from mainland cane areas, while stocks in their hands should provide them with another 250,000 tons. A total available for delivery of two million tons is thus indicated. Added to this, the beet sugar industry should deliver 500,000 tons.

Prices.—In the last few months world sugar prices have increased more than 100 per cent. So far as Cuba is concerned, World sugar does not come to the American market except for refining and subsequent export. At the present full duty rate of 1·87½ cents per lb. of raw sugar, freight and current world price would equal more than 4 cents. Since raw sugar prices are at present pegged at 3·50 cents, sugar from full duty countries cannot be sold except at a considerable financial loss by countries other than Cuba, such as Peru, Dominican Republic and others.

1 Any extra production of sugar for this purpose, bringing in £9 per ton, would obviously lower the average price for the whole sugar crop. It is deemed preferable to divert to alcohol manufacture a portion of the exportable sugar.

2 Abridged from 'Industrial Reference Service (Foodstuffs)'' No. 81 (U.S. Dept. of Commerce, Washington).

Development of the Practice of Evaporation.[1]

By NOËL DEERR, F.I.C. and ALEXANDER BROOKS, A M.I.Mech.E.

In the painting by VAN DER STRAET of a Sicilian factory of the sixteenth century, and in the engraving by JOHANN VISSCHER of a Brazilian factory of the early seventeenth century, the evaporation of the cane juice is shown to have been carried on in individual vessels hung over an open fire.

Usually in times when evaporation was conducted over a naked flame there were five boiling pans in series, the whole arrangement being known in the French colonies as the "batterie," in Mauritius as the "équipage" and in the English colonies as the "copper wall." This arrangement continued in the cane sugar industry till well past the middle of the nineteenth century; and indeed the copper wall is still used in factories of fair size in Barbados, to meet the small demand existing for the distinctively flavoured sugar made in this way.

Evaporation by Steam.—The first proposal to make use of steam instead of flame in evaporation appears indistinctly in patent No. 312 of 1692, granted to ANTHONY SMITH, while a definite technique embodying the use of a double-bottomed pan is found in patent No. 1492 of 1785, taken out by THOMAS WOOD. In patents No. 4032 of 1816, and No. 4197 of 1818, PHILIPP TAYLOR claimed broadly the use of tubular elements, as adapted to the use of high pressure steam, but presented no drawings. The objection to the Taylor pan was its complicated structure and that the inner tubes, adding to weight and first cost, presented no heating surface.

During the period 1829-40 the apparatus which became most used was that of ONÉSIPHORE PÉCQUEUR. It consisted of a single or double row of tubes terminating in a steam chest at either end, a trap being provided at the end remote from the steam entry. As with the Taylor pan, from which it derived, the heating element could swing about its long axis. Under the name of "eliminator" the Pecqueur pan is still found in many sugar factories, where it is used to bring juices rapidly to the boil, when the scum, which rises to the surface, is brushed off.

A distinct form of apparatus consisted of a hollow element through which steam circulated, rotating partially submerged in the material undergoing evaporation. In its movement it withdrew from the bulk of the liquid a thin film, which fell back into the container. The first hint of this method occurs in a patent granted to CHARLES WYATT, No. 4130 of 1817, and the first drawing appears in patent No. 5520 of 1827 granted to WILLIAM CLELAND. This type of apparatus came into extensive use after 1840, and is found in many forms. These apparatus are generally called Wetzel pans. For the next fifty years they continued in extensive use, the last one that operated in Mauritius being at Argy in 1900.

Evaporation under Vacuum.—Patent No. 3754 (1813) introduced an entirely new principle. This was the invention of the vacuum pan, by the Hon. EDWARD CHARLES HOWARD,[2] one of the few instances of a master-patent appearing complete and successful in operation in its first trial. This process is now so well known as not to require description. The adoption of the vacuum pan does not appear to have been rapid. J. A. LEON states that in 1827, the year of the expiry of the patent, only six firms, those of Hodgson, Major Rhode, Sutton and Davis, Croope, Craven and Severn and King had installed such plant. To these from other sources may be added the names of Brancher, Cooper and Fairrie making, with that of Howard, ten in all.

It was not till 1832 that the first colonial vacuum pan was installed, this being at the Vreed-en-Hoop estate in Demerara, which belonged to Sir JOHN GLADSTONE, the father of the statesman. The next were at Richmond and Land of Plenty in the same colony, and others were soon erected, so much so that the reputation of the product, termed Demerara crystals, can be traced to the superiority of the sugar made in these pioneer installations.

Other dates of introduction are: United States, 1832; Java, 1836, and Mauritius, 1844. In India vacuum pans were in use during the short-lived development of the forties. In Brazil the first vacuum pans were introduced in 1847; and in the Philippines not till 1879. Other dates are: Cuba, 1835; Guadeloupe, 1842; Jamaica, 1846; and Hawaii, 1863. On the continent of Europe the vacuum pan was first used in 1818 at the refinery of Vincent Mack at Jagerzeile near Vienna; then in a French refinery in 1824 at Marseilles; and in Germany, at the sugar works of August Helle at Magdeburg in 1835.

As mentioned, the vacuum pan came into being as a complete invention to which there was nothing to add in principle. Later developments had as their object the improvement of the efficiency of the heating surface, the coil being soon used in place of the double-bottom, the credit for this in France being due to HALLETTE. A tubular heating surface, usually called a "calandria," appears first in the patent of JOSEPH WALKER, No. 14,141 of 1852. The

2 A cadet of the ducal House of Norfolk whose interest in sugar derived from his marriage to the daughter of a London sugar refiner, also introduced the use of the leaf filter, the use of alumina as a clarificant, of the preliminary washing of raw sugar before melting and of the washing of sugar with syrup in place of water. He died from the effects of a heat stroke, after a visit to the stove room of his refinery. While the *Dictionary of National Biography* has particulars of fifty-four scions of the House of Norfolk it does not find room for one who, in many ways, was the most distinguished of all the Howards.

1 Condensed from a paper read before the Newcomen Society, London, October, 1941, and later to be published (with illustrations) in the *Transactions* of the Society.

arrangement of short coils in nests in substitution of a long helix, much of the heating surface of which was inefficient, is first found in the patent granted to EDWARD BEANES and CONRAD FINZEL, No. 57 of 1865.

Multiple Effect Evaporation. —As was the engine of Watt to that of Newcomen, so is the system of multiple effect evaporation first successfully operated by NORBERT RILLIEUX, if not indeed first conceived by him, to the process of evaporation in vacuo nvented by HOWARD.[1] This system which must have place among the world's greatest economic inventions[2] embraces the repeated interchange of the same quantity of heat in a chain of closed vessels, which are automatically maintained under continually reducing pressures. Say, e.g., 35 lbs. of steam are admitted to vessel I and used at double effect causing the removal of 70 lbs. of water, the total consumption of steam in evaporation and crystallization being 50 lbs., affording the removal of 85 lbs. of water, which at single effect throughout would have required steam equal to the weight of water removed in all. Actually in the sugar industry the most generally adopted plant is one operating at quadruple effect.

The first crude idea of the multiple utilization of heat is found in patent No. 5394 of 1826 granted to WILLIAM CLELAND. While there is here a definite utilization of heat it is of sensible heat only and not of latent heat, which can only be obtained with a reduction of pressure in the second vessel. To what, if any, extent this proposal was used we have been unable to find record. A scheme essentially similar in principle is illustrated by PECLET[3] as having been used by DEROSNE in French beet sugar houses as early as 1828. It is stated to have obtained a total evaporation of 9 to 10 lbs. of water per lb. of coal. The next step is described in 1833 in the French patent of DEGRAND, who made use of a combination of the Howard pan with the evaporative or surface condenser of ALEXANDER CLARK, patent No. 4665 of 1822, using beet juice or syrup as the cooling fluid, and replacing the injection condenser used by HOWARD.

This method of operation obtained no little extension in both beet and cane sugar industries, and in continental refineries. In Cuba it was installed for the first time at Amistad before 1840 and about the same time at La Mella. It was introduced at Réunion in 1839 and to Surinam in 1843. In Louisiana it was first used by VALCOEUR AIMÉ in 1845 and by P. M. LA PICE in 1846. We have found no record of its early use in British colonies, though one of us saw a plant still working in Barbados as late as 1904.

Although called by him "évaporation à double effet" the process of Degrand added nothing in principle to the cruder conception of Cleland. Pecqueur's French patent 6886, however, may claim priority as the first demonstration of the principles involved in multiple effect evaporation, though there is no record of the construction of his apparatus.

The second name connected with the invention of multiple effect evaporation is that of DEROSNE, who in 1836 took out English patent No. 7082 of that year. Two distinct apparatus are described. The first is a copy of Degrand's French patent of 1833. In the second, two Howard pans connected in series are distinctly shown. While no development followed from Derosne's design there is definite evidence that at least two plants were built, and put into operation in the islands of Martinique and Guadeloupe before 1843.[4]

The third distinguished name is that of NORBERT RILLIEUX, who was born on March 18th, 1806, in New Orleans, the son of VINCENT RILLIEUX and CONSTANT VIVANT, free quadroons. His father was a mechanical engineer of repute who, in 1825, sent his son then aged nineteen to Paris to complete his education. After holding a position of lecturer in mechanical engineering at the École Centrale he returned to Louisiana in 1834. The slights to which RILLIEUX was exposed in America because of his African ancestry determined his return to France in 1861, where he continued to improve the details of his process. He died at Paris on October 8th in his eighty-ninth year and was buried in the cemetery of Père Lachaise. In 1934 a number of persons connected with the sugar industry honoured themselves by placing in the State Museum in Jackson Street, New Orleans, a tablet to his memory.

His first patent is U.S. No. 3237 of 1843, showing two Howard pans in series. His second No. 4780 of 1845, shows a triple effect with horizontal tubular heating surfaces. His patent drawings show both three pan and four pan apparatus. The last pan in both designs was a graining pan and could be operated at will with virgin steam or with vapour separated from the first effect. Third and fourth pans used a common condenser. This arrangement was not adopted, and the Rillieux plants which were built were isolated triples.

Of the part played by RILLIEUX in invention and in establishing the multiple use of steam there is full record. He states that in 1832 when resident in Paris he had conceived the idea of multiple effect evaporation in vacuo and communicated it in part to DEROSNE. In 1834 he returned to New Orleans. In 1844 he installed plant at the Scarsdale plantation

1 Operation under vacuum is not essential for the application of evaporation in multiple effect. The process however derives from Howard's invention. 2 The production of sugar yearly is now about 30,000,000 tons, entailing the evaporation of about 300,000,000 tons of water. At single effect this would require about 40,000,000 tons of coal and at quadruple effect only 10,000,000 tons. Thus in the sugar industry alone a saving of 30,000,000 tons of coal a year is indicated.

3 "Traité de la Chaleur." (Paris, 1843). 4 "Fabrication actuelle du Sucre aux Colonies" (Paris, 1843), p. 81.

of Theodore Packwood.[1] This was built in accordance with the design shown in his second patent, and was the first plant to operate successfully. By 1849 the process was in use in thirteen sugar houses producing 4,500 tons of sugar.[2] From Louisiana the process spread to Cuba, Mexico and to Peru. In Cuba the earliest plants, all erected about 1850, were those at Ascuncion, Alava, Santa María, Minerva and Julia.

The accepted story of the introduction of the Rillieux apparatus to Europe is that at the time when RILLIEUX was perfecting his plans in America, under a pledge of secrecy he gave a copy of his drawings to ANDRAEA, a German engineer, who sent them to TISCHBEIN, who failing to understand them sold them to the French engineer and manufacturer, CAIL. However this may be, a French patent on multiple effect evaporation was taken out by J. F. CAIL, No. 5563 of April 25th, 1850, with an addition dated December 1st, 1851.

The drawings in the first part of this patent are facsimile copies of those in Rillieux's second patent. Those referring to the addition show an apparatus with vertical tubes, broadly equal to what has now become the standard design. Cail's English patent, taken out in the name of DANIEL SHEARS, No. 13286 of 1850, follows the French patent, but with no reference to the addition. The first description of Rillieux's apparatus in Europe is due to DUREAU,[3] who saw plants at work in Louisiana in 1848. The first plant to be erected in Europe was at Couincy near Douai, with others soon afterwards at Corbehem and at Sin beet sugar factories.[4] These were put into operation about 1850.

For the next twenty years progress was slow, and for this troubles arising out of imperfections in design may have been responsible. One of the greater difficulties was that the effect of the presence of air or of incondensible gases in decreasing the rate of heat transmission was not recognised, and all the earlier apparatus operated at a low heat exchange efficiency.

It was only about 1870 after JULES ROBERT of Seelowitz in Austria had perfected his system of the diffusion of beets, entailing a greater dilution of the expressed juice, that the demand for the apparatus increased; to its rational design this technician contributed so much that he is sometimes credited with its invention, and the whole apparatus is sometimes called a "Robert." Other pioneers of this period were the Austrian engineers WELNER and JELINEK, who developed the horizontal type of apparatus with which RILLIEUX had established the process.

It was at this time too that the use of the apparatus began to appear in the Old World cane sugar industry. The one first on record was installed in 1867 by JOSEPH PORTAL at Anse Jonce in Mauritius,[5] a second being put into operation at La Gaieté by ICERY a year later.[6] To India it was brought before 1870 by MINCHIN at his diffusion factory at Aska, Madras; to Egypt at Beno Mazar in 1872; and to Java at Poerwadie in 1873, and at Djattiwangi in 1875.[7] In Demerara the earliest installations were those at Hope, Windsor Forest, Vryheid's Lust and Providence, all made about 1880. By this time its use was fast becoming general practice, not only in the sugar industry, but in others dealing with the economic evaporation of large quantities of liquid.

In 1880, when seventy-four years old, RILLIEUX placed the corner stone on the edifice which he had erected. This is known as his second principle which adds further to the economy of the system. In this scheme which soon became widely adopted, steam separated from the first vessel of a double effect is used in the evaporation of the syrup to crystallization in a vacuum pan, work which till then had been performed with virgin steam. The total consumption in one case was 42·5 lbs. steam compared with the 50 lbs. formerly necessary. This arrangement, for which there is no other claimant than RILLIEUX, is described in English patent No. 5296 of 1880. In the patent drawing a triple effect is shown, by the use of which the consumption of steam is further reduced to 38·33 lbs., for a total evaporation as before of 85 lbs. of water. A modification was later introduced by the German engineers, PAULY and GREINER. In this a second vessel, called a pre-evaporator, independent of the evaporator and connected to the crystallizing pan, is employed. The heat economy is the same as for the Rillieux system of separated steam.

We conclude with a few references to subsequent outstanding developments. W. P. ROBERTSON, English patent No. 790 of 1872, described the regeneration of low pressure steam with steam of higher pressure and its use in multiple effect, the possibility of this having already been foreseen by PELLETAN as early as 1840. PRACHE and BOUILLON, patents No. 26,005 of 1905 and No. 9276 of 1909, further developed this process, which has now passed into the phase of actual operation under the name of thermo-compression.

WIEBEL, patent No. 5143 of 1879, and WIEBEL and PICCARD, patent No. 1761 of 1883, claimed regeneration of low pressure steam by mechanical compression, and its use in multiple effect. This system has been used in Switzerland where supplies of cheap water power are available. Film evaporation as opposed to bulk evaporation has been developed and extensively used under the patents of HOMER TAYLOR YARYAN, No. 14,162 of 1886 and No. 213 of 1888; of S. M. LILLIE, patents No 3006 of 1888, No. 12,391 of 1888 and No. 11,786 of 1890; and of PAUL KESTNER, patent No. 6373 of 1903.

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1 C. A. BROWNE, *I.S.J.*, 1939, p. 176. 2 *Loc. cit* 3 "La Génie Industrielle." (Paris, 1852). Vol. 2 p. 357.
4 "L'Industrie du Sucre depuis 1860." DUREAU. (Paris, 1894) p. 29. 5 "Mauritius Almanac," 1868.
6 A. NORTH COOMBES, Evolution of Sugar Cane Culture in Mauritius, p. 133. 7 Java *Archief*, 1909, 17, p. 629.

Plastics from Bagasse

And other Agricultural Residues.[1]

By S. I. ARONOVSKY and T. F. CLARK, Agricultural Byproducts Laboratory, Ames, Iowa.

Numerous methods for the treatment of lignin-containing materials have been suggested.[2] In 1933 the Forest Products Laboratory at Madison, Wisconsin, proposed methods of producing plastic moulding compounds from some agricultural residues. These methods consist essentially in hydrolysing or digesting the raw material at elevated temperatures and pressures with dilute acid or with aniline, and in mixing the hydrolysed residue with suitable plasticizers. They were chosen for the preliminary studies on bagasse carried out at Ames, dealing with the effects of such variables as temperature, pressure, period of hydrolysis, type and amount of plasticizers, etc. This resulted in a number of modifications of the methods.[3]

Acid Digestion.—A satisfactory moulding composition was obtained from bagasse digested for 30 mins. with 1 per cent. sulphuric acid at 135 lbs. per sq. in. After filtering, washing, drying and grinding, the powder was mixed with 8 per cent. each of aniline and furfural. Specimens moulded at about 325°F. (163°C.) under a pressure of 3500 lbs. per sq. in. had a fairly high flexural strength or modulus of rupture (approx. 7000 lbs. per sq. in.), 2·7 per cent. moisture absorption (fairly low for a 48-hour immersion), a Shore scleroscope hardness of 85, and a specific gravity of 1·42. Some of the physical properties of the moulded material are indicated in Table I. The moulded products were dense, black, opaque, lustrous and readily machined with high-speed cutting tools or carborundum wheels. Being uniform in physical structure the moulded products may be ground, sanded and polished throughout their entire body.

Aniline Digestion.—Early tests with the aniline-digestion method gave specimens exhibiting flexural strengths as high as 9000 lbs. per sq. in. Extending this investigation, moulding compositions were prepared from a series of 24 digestions in which the effects of the various factors outlined above were studied. The aniline-digested residues were washed, dried, ground, and mixed with plasticizing agents such as furfural alone, furfural and aniline, or furfural and phenol. Data showing the maximum, minimum and average strength characteristics and other physical properties of 60 specimens moulded from powders prepared under varying conditions are given in Table I.

Alkaline-Furfural Digestion.—Preliminary tests on digesting bagasse in an alkaline furfural solution and precipitating the dissolved lignin complex by acidification gave indications that this method of digesting with a combination of plasticizing and pulping agents merited further consideration. Although moisture absorption of specimens moulded from compositions to which no additional plasticizing agents had been added was relatively high, the flexural strength approached 6000 lbs. per sq. in., as indicated in Table I.

The experiments indicated that some of the variables in the preparation of the moulding powders

TABLE I.

Treatment.	Yield of Digested Material per cent. Dry Bagasse.	Flexural Strength or Modulus of Rupture lbs./sq. in.	Moisture Absorption per cent. Oven-dry Moulded Product.	Specific Gravity.	Hardness (Shore Scleroscope).
Acid-Hydrolysis*—					
Maximum		6983	3·37	1·42	87
Minimum	—	5805	2·29	1·42	83
Average	65	6349	2·69	1·42	85
Aniline-Hydrolysis†—					
Maximum	—	6900	2·99	1·38	90
Minimum	—	3175	0·64	1·28	71
Average	90	4650	1·27	1·34	83
Soda-Furfural Hydrolysis‡—					
Maximum	—	5982	4·04	1·41	81
Minimum	—	5560	3·57	1·41	81
Average	79	5771	3·81	1·41	81
Commercial Phenol-Formaldehyde moulding compounds for comparison:					
1	—	7063	0·34	1·34	98
2	—	7107	0·42	1·41	95
3	—	6898	0·38	1·38	95

* Digested material plasticized with aniline and furfural.
† Digested material plasticized with furfural, furfural and aniline, or furfural and phenol.
‡ No plasticizers added.

1 Abridged from *Manufacturers' Record*, 1941, 110, pp. 22-25, 59. 2 U.S. Patents, 1,932,255; 2,077,884; 2,080,078; 2,130,783.
3 *Modern Plastics*, 1939, 16, No. 7, p. 42; 1940, 17, No. 10, p. 59. *Ind. Eng. Chem.*, 1940, 32, p. 1399.

have definite effects upon the physical properties of the moulded product. A low water-bagasse ratio in the digestion charge is necessary for maximum plastic flow and maximum moisture resistance of the finished plastic, and a high ratio is desirable for maximum strength. The optimum amount of aniline for digestion is 20 to 25 per cent. of the weight of dry bagasse.

Lower digestion pressures tend to give good strength characteristics, while higher pressures improve the plastic flow and moisture resistance. A shorter digestion period at higher pressure increases the strength of the plastic, but a longer cooking time at lower pressure is more desirable. A relatively large proportion of fines in the powder apparently enhances the strength of the resulting product, provided the original fibre length is not reduced drastically. Plasticizing the digested material before grinding tends to increase the strength of the moulded product.

Variation of Quality.—Based on these findings, conditions were selected which would be expected to produce a moulding compound of a reasonably high degree of flow and good strength characteristics. A moulding powder prepared from bagasse under the chosen conditions yielded moulded specimens which gave results in line with expectations. This indicates that the moulding qualities and physical properties of bagasse powders can be varied to meet definite requirements within reasonable limits.

Bagasse plastics with metal inserts have been moulded successfully in this laboratory, indicating excellent adhesion of the metal to the plastic. Veneers (woods, plastics, metals, etc.) may be applied either at the time of initial moulding or as a subsequent operation. Although the moulding powders described above always give a lustrous black product, it is possible to incorporate suitable pigments to produce coloured and mottled objects. The plastic compositions prepared from the aniline-hydrolysed bagasse exhibited, in general, greater plastic flow, flexural strength, and resistance to moisture absorption than products prepared by the acid-hydrolysis and alkaline-furfural methods.

Utilization.—These agricultural moulding compounds have aroused a great deal of interest in the automotive and rubber industries. It was found that the aniline-bagasse moulding powders can be compounded with some synthetic rubber materials, as well as with natural rubber. This led to a number of possible applications. Automobile steering wheels moulded from a mixture of aniline-bagasse powder and synthetic rubber have passed all laboratory and service tests.

The moulded plastic may find use as electrical insulation material in the manufacture of radio and other electrical equipment. The strength characteristics, workability and relatively high moisture resistance of products moulded from agricultural residues may be of interest to the building and furniture industries.

Costs.—Conservatively estimated costs of materials for producing moulding powders by the methods outlined are indicated in Table II. The estimated cost of raw materials for the aniline-hydrolysed moulding composition is somewhat greater than that for the soda-furfural powder and more than twice as great as that of the raw materials used for the acid-hydrolysed powder. However, the aniline-hydrolysed powders have certain advantages over those prepared by the other two methods, as discussed previously.

An estimate of the final cost of the finished powder, on a commercial basis, would necessarily include the cost of labour, steam and power, equipment, maintenance and depreciation, taxes, overhead, etc. These items would vary with the type of powder, with the production, capacity and location of the plant, and with other economic conditions. Reasonably accurate estimates of these cost items would require pilot-plant rather than laboratory studies.

Comparative investigations on various agricultural residues, including wheat, oat and rye straws, cornstalks, corncobs, flax shives, tobacco stems, bagasse, and lignin residues from the production of furfural, are being conducted at this laboratory. Complete data on the physical properties of moulded products from these various materials are not yet available, but preliminary observations indicate that a number of differences exist. However, the black colour and outward appearance of the moulded product are very much the same for all these raw materials.

TABLE II.

Raw Materials.	Acid-Hydrolysed — Quantity Required lbs.	Acid-Hydrolysed — Cost	Aniline-Hydrolysed — Quantity required lbs.	Aniline-Hydrolysed — Cost $	Soda-Furfural — Quantity required lbs.	Soda-Furfural — Cost $
Bagasse, oven-dry, at $8·00 per ton	2630	10·52	1900	7·60	2165	8·66
Sulphuric Acid, 66°, at $16·50 per ton	27	0·22	—	—	910	7·41
Caustic Soda, 76 per cent., at $2·30 per cwt.	—	—	—	—	660	15·18
Aniline, at $0·15 per lb.	135	20·25	535	80·25	135	20·25
Furfural, at $0·10 per lb.	135	13·50	135	13·50	395	39·50
Zinc Stearate, at $0·35 per lb.	17	5·95	17	5·95	17	5·95
Total cost per ton of plasticized powder	—	50·44	—	107·30	—	96·95
Cost per lb. of plasticized powder	—	0·025	—	0·054	—	0·049

The figures are based on 1 ton of finished moulding powder using average yields. They do not include the costs of labour, steam and power, equipment, maintenance and depreciation, taxes, overhead, etc.

Summary.—It may be seen from the foregoing studies on bagasse that it appears to be a suitable raw material for the production of low-cost moulding compounds. Its ready availability in sizable quantities at sugar mills is a factor which favours this raw material at the present time. Experimental bagasse moulding powders have produced plastic materials with dielectric and other strength characteristics and with resistance to moisture absorption similar to those of phenol-formaldehyde and phenol-furfural moulding compounds. The relatively low cost of moulding powders produced from bagasse and other agricultural residues should be of considerable interest to the automotive, rubber, electrical, furniture and building industries, where large volume production is pr[illegible]

The Clarification of Cane Juices.[1]

Optimum Liming in Sulphitation. Application of Pre-sulphitation.

By D. R. PARASHAR, Imperial Institute of Sugar Technology, Cawnpore.

Nearly 90 per cent. of the sugar factories in India employ the sulphitation process, but the methods of liming adopted so vary that each factory practically follows its own system. Some add the lime in the cold, while others at temperatures from 100 to 150°F. (38 to 66°C.), adopting either pre-liming (in the same or in separate vessels), or simultaneous liming and sulphiting. This investigation has been undertaken to establish the optimum degree of liming for high and low purity juices under different systems of clarification, and to study the effects of varying the quantity of lime used.

A representative sample of the cold raw juice was divided into four or five parts of 500 c.c. each, and treated with different proportions of milk-of-lime (0·8 to 1·8 per cent.) as is commonly done in sugar factories. After thoroughly shaking the mixture, it was filtered and its *pH* determined colorimetrically, this being done with the view to ascertaining approximately the *pH* of the juice when the entire amount of lime is added in bulk.

Arrangements were also made to add the lime in the liming and sulphitation vessels between the limits normally prevailing, samples of the raw and treated juice being taken from each tank, boiled in the laboratory, and allowed to settle in 1000 c.c. graduated cylinders, the following being noted under comparable conditions: (1) rate of settling and clarity; (2) volume of mud; (3) Brix, pol. and purity; (4) glucose/sucrose ratio; and (5) calcium salts, colloid content and colour.

Working in this way, observations were made of the following methods of working: *A*, separate liming and sulphitation at 100°F.; *B*, adding milk-of-lime directly to the juice (pre-limimg at 120°F.); *C*, pre-liming at 140 to 150°F.; *D*, pre-liming at 158°F.; *E*, slightly sulphiting, then adding the whole of the lime in bulk at 158°F.; *F*, simultaneous liming and sulphiting at 158°F.; *G*. Ditto, using 140°F. Experiments were also made on pre-sulphitation at 120°F.

Figures obtained show that, whereas in some cases there is a gradual rise in the volume of the mud obtained with increasing quantities of lime, in other cases there is a gradual fall. This may be due to two factors: (1) the action of double heat; and (2) use of the acid or alkaline zone of reaction of lime and sulphur dioxide.

Double heat hastens the rate of settling considerably, depending on the temperature at which the lime and SO_2 react, the higher the temperature the more granular being the precipitate. Much, however, depends upon the medium in which the reaction occurs, so that if the precipitate is formed in the alkaline range the flocs become hydrated, thereby effecting an increase in the mud volume. If, on the other hand, the reaction takes place mostly in the acid range, the rate of settling is quicker, the mud being more compact.

The Pre-liming Process.

It is clear therefore that when liming precedes sulphitation (i.e., the pre-liming process), settling will be slower and the volume of mud higher, and this is particularly so when this effect is combined with a low degree of double heat. Thus factories employing pre-liming in any form (in the same or in separate vessels) will always require a large filter-press capacity. A low degree of liming in pre-liming would mean less mud, but it also means an incomplete removal of the impurities. Pre-liming at the higher temperatures appears to yield slightly better results so far as clarity and settling are concerned.

On the other hand, in the simultaneous and the pre-sulphitation methods, the results obtained were more encouraging. But in the "simultaneous" method as here followed, the full dose of lime was discharged in bulk in the sulphitation vessels without or with a slight previous sulphitation. Addition of lime was so regulated as to complete the reaction between lime and SO_2 mostly in the acid zone, except towards the end, when low alkalinity may be desirable.

[1] *Proc. 9th Conv. Sugar Tech. Assoc. India*, 1, pp. 157-175 (here abridged).

It was found that the initial acidity of the raw juice appears to exert a marked influence on the rate of settling and the compactness of the mud obtained. For proper coagulation of impurities one of the following requirements appears to be necessary: Either a high acidity (i.e. a low *pH*) may be combined with a low temperature, or a low acidity with a high temperature (i.e. 70 to 75°C.) before the addition of lime starts.

Addition of lime in the latter case should be so regulated as to provide the maximum benefit of acid reaction to the juices; or the simultaneous method would yield better results if worked partly on the principle of pre-sulphitation. This method may be helpful to those factories which on account of shortage of SO_2 cannot derive the advantage of high acidity. But an adequate supply of SO_2 is an important requirement for the proper clarification of juices whichever method may be adopted.

Initial high and low acidities also account for differences in the mud volumes of high and low purity juices treated with equal quantities of milk-of-lime. Assuming that the *pH* of the low purity juice is 5·1 and that of high purity is 5·9, and that these are both sulphited initially for say between one and two minutes, the initial acidity will be much lower in the former than in the latter case. Therefore, the mud volume would be more compact in low purity than in high purity juices.

Low rises in purity occur when the addition of lime precedes sulphitation (pre-liming), the coagulation of impurities as indicated being not so efficient when the juices are treated purely in the alkaline range. It has also been seen that if the final *pH* of juices is adjusted in the acid range (say 6·8 *pH*), the settling will be quicker than if one works in the alkaline range (say 7·3 *pH*). Consequently, the rise in purity is comparatively higher in the former case.

Figures obtained also show that with increases in the quantity of lime the rise in purity is not proportional. After a certain stage this rise either remains constant or it may even decrease, more particularly in the pre-liming process. Perhaps with the addition of heavy quantities of lime there occurs slight re-peptization of some of the impurities already precipitated. This is borne out to a certain extent by data on colloidal content.

Results also show that the calcium content of the clarified juices are influenced to a large extent by the degree of liming, this decreasing with the increase in the lime addition. After a certain stage, however, there is no further decrease. Glucose decomposition is possible even at low temperatures, as 100°F. (38°C.) when pre-liming is used, and the higher the degree of liming the greater the decomposition. Beyond 130°F. (55°C.) the amount of glucose decomposition is of course more marked.

In regard to colour, the amount again depends on the quantity of lime added, and the method of clarification adopted. In general with a low degree of liming the precipitation of colouring matters is complete, the juices being also turbid. But with an increase in the dose of lime, the clarity improves, though the total colour left in the juice will depend upon the system of clarification.

Even at the comparatively low temperature of 82·5°F. (28°C.) some colour may form in the presence of an excess of lime,[1] and no time should be lost before gassing is commenced. With the large excess of lime as is used in carbonatation a considerable quantity of colour is removed, but in sulphitation-defecation an increase amounting to about 10 per cent. may result.

It is obvious that separate liming and sulphitation in which the juices are kept in contact with lime for a fairly long time is to be condemned in all respects. Low temperatures as usually maintained are no safeguard against colour formation. In the "simultaneous" method glucose decomposition at temperatures higher than 55°C. is unavoidable, resulting in the formation of dark coloured compounds. Of simultaneous sulphitation and pre-sulphitation the latter gives the better results.

The Pre-sulphitation Method.

Even better results will be obtained when the raw juice is sulphited to 3·8 to 4·0 *pH*, limed to 7·4 to 7·6, and back-neutralized to 7·0 *pH* with some sulphited juice at 3·8 to 4·8 *pH*. This method of working pre-sulphitation gives results definitely superior to the pre-liming judged according to the criteria mentioned. An attempt was made to see if this method could be worked with the existing equipment in use, the procedure adopted being as follows:—

Sulphitation of some of the raw juice was started and continued until 4·0 *pH* was reached, after which this sulphited juice was discharged into a storage tank below. In the meantime the sulphitation of the main portion of the raw juice was started in another tank, and as soon as 4·0 *pH* was reached the gas was stopped, and the addition of milk-of-lime started, being continued until 7·4 to 7·6 *pH* had been reached. Then sufficient of the sulphited juice from the storage tank below was pumped in until 7·0 *pH* was reached. A temperature of 50°C. (122°F.) should be used in carrying out the pre-sulphitation process. In pre-sulphitation and in this modification of it no further gain is achieved by the addition of a quantity of lime larger than what is necessary to give 10·6 *pH*, which is accordingly fixed as the optimum degree of liming.

[1] See Schweizer, *Archief*, 1913, 21, p. 840.

Chemical Reports and Laboratory Methods.

Plastics from Bagasse. O. W. Willcox. *Sugar*, 1941, **36**, No. 9, pp. 20-23, 28.

It is now possible to say something further about the new plastic, "Kanex," which has been developed by Valentine Sugars, Inc., of Lockport, Louisiana, by the treatment of bagasse with certain chemicals.[1] At the present time, plastics are being made from a variety of substances, the best known of which are phenol and formaldehyde, which form the basis of the "Bakelite" products, while others use casein, urea, acetic acid, acetone and other products. But the possibilities of a cheap material as bagasse being used as the raw material for the manufacture of plastic-forming constituents have aroused much interest in the industry.

Bagasse, as is well known, is formed principally of cellulose and lignin, it being the latter which is the plastic-forming constituent. It is necessary to destroy or transform the cellulose in some way or other, for which purpose aniline has been found to be the most suitable chemical to use. There are of course plenty of other vegetable by-products and waste products containing lignin, as corn stalks and straw, but these are really not cheap, as they would have to be collected in relatively small quantities over wide areas. In the case of bagasse, on the other hand, the cost of collection has already been charged to the sugar product.

One can proceed in the following manner : 190 lbs. of bagasse (coarsely shredded and containing not more than 7 per cent. of water) are heated in an autoclave with 53·5 lbs. of aniline (28 per cent. on the bagasse), using high pressure steam at 100 lbs. per sq. in., the mixture being continuously stirred during the operation, which lasts about three hours. At the end of this time, a black solid has been formed, which is separated by filtration, washed with hot water, dried at 220°F., and ground to powder.

This black powder (its yield is about 200 lbs.) has now to be "plasticized," for which purpose a large variety of chemicals are available. After a good deal of investigation, it was found at Lockport that the most suitable appears to be furfural (which itself can be produced from bagasse pith), though mixtures of furfural, aniline and phenol may be used. By suitable treatment with the plasticizer a thermo-plastic results, that is to say, a substance which heated to a sufficiently high temperature (200 to 360°F.) under a sufficiently high pressure (up to 3500 lbs. per sq. in.) will take the form of any desired mould.

This process can be varied to produce plastics of very different properties. Thus, for maximum strength the water-to-bagasse ratio of the mixture in the autoclave should be high, and for maximum flow and water resistance it should be low. A short time of digestion assists in giving strength. Also the nature of the plasticizer is of importance, and the fineness of the black powder obtained from the autoclave appears further to be of some effect.

A cheaper method than aniline of destroying the cellulose is to hydrolyse it by cooking under pressures with sulphuric acid, but the plastic so obtained, though similar in many respects to that made by the aniline process, has a lower plastic flow, less strength, and inferior resistance to water absorption. However, the already cheap acid process may be made yet cheaper if the liquor obtained in the hydrolysis, which contains sugars, be boiled down for incorporation with a stock food, or if it be fermented to alcohol.

Bagasse plastics are in all cases intensely black, and therefore do not lend themselves to the manufacture of fancy articles. But they already appear to have an assured market in the automobile and electrical industries. Perhaps their largest outlet will be in the form of lustrous and strong sheets that can be used in cabinet work, in floor tiling and the like. They may yet come to compete with the soy bean plastic which Henry Ford is considering for the moulding of automobile bodies and aeroplane fuselages.

Muller's Process for the Polarimetric Determination of Sucrose (compared with the Double Polarization Method). R. Pilot. *Revue Agricole* (Mauritius), 1941, **20**, pp. 140-147.

Charles Muller's process of determining sucrose by polarization after having destroyed the optical activity of the reducing sugars by heating with an alkaline reagent is resuscitated.[2] It is recommended as being preferable to the double polarization method as at present used, being more easily manipulated by laboratory assistants. It gives results that compare well with those obtained by double polarization with acid hydrolysis.

The alkaline reagent used for the destruction of the optical activity of the reducing sugars contains 32 grms. of sodium hydroxide, 25 grms. of Rochelle salts, and 11 grms. of bismuth subnitrate in 500 c.c. of water. 50 c.c. of the solution of the sample (sugars, massecuite and molasses, 10 per cent., syrups 30 per cent., and juices, undiluted) are placed in a 100 c.c. flask with the alkaline reagent, the amount of which varies according to the reducing sugars present, being for juices, 0·7 to 1·0 c.c.; for syrups, 1·3 c.c.; for massecuites, 1·5 to 2·8 c.c., and for final molasses, 3·8 c.c.

The flasks containing the solutions thus prepared are heated in a boiling water-bath for 15 min. at the end of which time they are immediately cooled in running water to standard temperature. Some water is added to the contents of each flask, then just the

[1] *I.S.J.*, 1941, pp. 361, 371, 377, 386. [2] *I.S.J.*, 1916, p. 274.

	Clarified Juice.	Syrup.	Massecuites. A	B	C	Molasses
Brix	15·52	48·13	94·45	92·70	91·10	86·50
Polarization	12·13	39·70	69·68	61·36	53·30	30·16
Reducing sugars, per cent	0·94	3·33	7·35	9·26	11·36	17·86
Sucrose by Muller	12·40	40·38	71·76	63·96	56·94	36·14
Sucrose by double polarization	12·42	40·12	71·21	63·99	56.65	36·40

amount of basic lead acetate solution necessary for complete defecation,[1] in adding which the flask is held in an inclined position to avoid entanglement of air by the very viscous precipitate. Usually the basic lead acetate solution (30°Bé.) is added in the following amounts : clarified juice, 1·5 c.c.; syrups, 2·2 c.c. massecuites, 2·5 to 3·8 c.c.; and final molasses, 5·5 c.c.

Mixing is effected by rotating the flask, and finally after adding a few drops of alcohol to disperse bubbles of air, their contents are made up to volume, filtered and polarized. Generally the filtrate is amber coloured and brilliantly clear. A series of determinations were carried out by this method, and the results obtained compared with those found by the double polarization method in which hydrolysis was carried out with hydrochloric acid in the cold during twelve hours (see table herewith).

Metal Protection by Paints. JAMES A. MEACHAM. *Proc. 14th Conf. Assoc. Sugar Tech. Cuba*, pp. 221-224.

All agree that complete protection to metal would be afforded if a thoroughly waterproof coating of paint could be applied, but it is found that no coating is completely impervious to moisture, the basic cause of all corrosion. To afford the best protection possible, the initial coat of paint in contact with the metal must contain chemically-active pigments capable of inhibiting corrosion, even though the film permits to some extent the passage of moisture through it.

Pigments composed of red lead, lead chromate, and blue lead have through years of trial been found actually to retard atmospheric corrosion. Therefore as a preliminary step every metal surface should be coated with an inhibitive primer of this type. But the finishing coat must also be a suitable one, and should serve as a protective coating for the primer, besides providing the desired colour. Such finishing coats must be essentially resistant to the destructive influence of weather, sunlight and fumes present in the air.

In recent years great improvements have been made in the use of synthetic resins. They have greatly increased water resistance, hastened drying, made harder and tougher finishes, and materially improved the appearance by enabling them to retain their gloss for long periods of time. Such paints however, are not much used for wood surfaces, being selected for out-of-door work on metal, under which conditions under the most adverse conditions they retain their gloss and exhibit outstanding weather durability.

A point of importance is the thickness of the coating applied. It can be demonstrated that the ability of a paint film to resist the passage of water is in direct proportion to the film thickness. As many as four coats are now being recommended for new work on important structures with paints of proper consistency, two priming and two finishing coats being usually applied. However, for ordinary work good protection in most classes of work can be obtained with three-coat work.

It is certain that no phase of metal protection with paint is more important than the preparation of the surface, both for new steel as well as for repainting work. It is essential that rust, mill scale and foreign material should be removed before the paint is applied, otherwise the result will not be a durable one. Various methods of preparation have now come into use, as sand blasting, wire brushing, flame cleaning, and chemical treatment.

Sand-blasting, according to some authorities, has the disadvantage of making the exposed steel surface highly reactive, and liable to corrode very rapidly, and in any case it must be followed immediately by the application of the primer. Wire brushing by hand or power will remove loose scale, and if the work is well done is a very satisfactory means of preparing steel surfaces for painting. Careless work, however, is not of much use, and the closest inspection of the job is necessary.

Flame cleaning is a new development, which offers great possibilities, but so far has not been very widely tested. Chemical treatments rely generally on proprietary compounds containing phosphoric acid, which converts the steel surface into a film of iron phosphate, which is incorrodible. Under closely controlled conditions, as in a shop on a manufactured product, this method is highly effective; but for structural steel work the practical difficulties in the way of proper application have not been entirely overcome.

Measuring the Moisture Content of the Soil. G. J. BOUYOUCAS and A. H. MICK. *Michigan Agricultural Experiment Station, Technical Bulletin*, No. 172.—This is done by measuring the electrical resistance of porous blocks which absorb moisture in proportion to that present in the soil surrounding them, and forms a very convenient system of controlling irrigation on the estate. Each absorption block is made of some suitable porous material, and is about the size of an ordinary matchbox, and is connected by means of

1 Use is made of the reaction with otassium iodide, which in the presence of lead gives a yellow ppt. of PbI_2.

leads to a small panel, each point of measurement joining up blocks situated at different depths. Using a suitable instrument, a reading may be made in a few seconds. Naturally as the soil dries out, the block loses moisture in proportion, such changes being indicated by the resistance reading. When the resistance of a block becomes constant at say 500 ohms, the soil in which it is embedded will be about its field capacity, i.e., it is holding all the water that is desirable under the field conditions. Taking the other extreme, if the resistance of a block passes about 60,000 ohms, it means that the surrounding soil moisture is approaching an excessively low level, in other words that the wilting range of the soil has been reached. Probably the optimum conditions for plant growth will exist between about 1000 and 5000 ohms, which would indicate that there is plenty of water for plant requirements, and at the same time a satisfactory soil aeration.

Hygroscopicity of Certain Sugars. K. L. BASU and B. K. MUKHERJI.[1] *Proc. 9th Conv. Sugar Tech. Assoc. India*, I. pp. 239-250.—Conclusions which these authors draw from their experiments are : "Hygroscopicity of pure sucrose is less than that of impure sugar. These impurities may be glucose, fructose or mineral matter from molasses. By transferring from a higher to a lower relative humidity, the moisture content can be reduced, but there will be caking. Once the moisture goes high, there is an optimum below which the moisture cannot be reduced. In the case of sucrose, this is 1·7 per cent., and in that of glucose it is 10 per cent. At a r.h. above 75 per cent. at the temperature considered, there is a region of unstability, and moisture once absorbed cannot be brought down. Pure sucrose can be safely stored at 65 per cent. r.h. and 30 to 35°C.; the presence of glucose and ash is less injurious than that of fructose and consequently of invert sugar. For safe storage without deterioration from moisture absorption it is therefore wise to manufacture as pure a sugar as possible, and to store it in humidity-controlled godowns, the optimum r.h. to be maintained depending on the climatic conditions and also on the quality of the sugar."

Manufacture of Furfural from Bagasse. HUSAHARU NISIO and SIRO AOKI. *Rept. Govt. Sugar Expt. Sta., Tainan, Formosa*, **7**, pp. 231-237.—In laboratory experiments, 10 grms. of bagasse pith (with 10 per cent. of moisture) were hydrolysed for 3 hours at 3 atmos. pressure with 1·5 to 2·0 per cent. of sulphuric acid in the presence of 0·5 to 1·0 per cent. of aluminium chloride. Furfural yield was about half of the pentosan content of the pith (24·5 per cent.).

Sugar Dust Explosions. WALTER H. GECK. *Deut. Zuckerind.*, **65**, pp. 365-366, 388-389, 518.—These articles outline the causes of sugar dust explosions, as these phenomena are understood at the present time. They are characterized by : (1) a minor, first explosion ; (2) a whirling of settled dust ; and (3) a final devastating explosion. But these three stages generally occur so quickly that only one sound is heard.

Production of Pulp from Bagasse. S. D. WELLS and JOS. E. ATCHISON. *Paper Trade J.*, **112**, No. 13, pp. 34-38.—This article outlines the procedure by which pulp for use in making high-grade book or bond paper can be produced from the fibrous element of sugar factory bagasse. Pith can be mixed with kraft pulp to produce an improved paper board using as much as 70 per cent., the pith having the effect of increasing the stiffness of the board and of enhancing its appearance and formation.

Sugar (Sucrose and Dextrose) Syrups Specific Gravity and Brix Figures. K. E. LANGWILL. *Manufacturing Confectioner*, 1941, **21**, No. 3, pp. 17-18, 35.—Tables are presented showing for 20, 40 and 60 per cent. concentrations the specific gravity, refractive index and Brix degree of solutions of : (1) sucrose, (2) dextrose, and (3) two parts of sucrose and one of dextrose.

Gluconic Acid Production. N. PORGES, T. F. CLARK and S. I. ARONOVSKY. *Ind. & Eng. Chem.*, 1941, **33**, pp. 1065-1067.—In the semi-continuous production of gluconic acid from glucose by *Aspergillus niger*, the mycelia were recovered by pressure filtration, and re-used in nine successive fermentations of media containing 16 grms. of glucose per 100 c.c. Centrifugal filtration was used as the means of separation.

Non-Existence of "B-Sucrose." G. VAVRINECZ. *Deut. Zuckerind.*, **65**, pp. 449-450.—Results of careful determinations of the melting point and density, as well as of crystallographic, piezo-electric and x-ray comparisons, definitely show that sucrose crystallized from methyl alcohol (i.e., "*B*-sucrose"[2]) to be identical with normal sucrose.

Determination of Arsenic in Molasses. A. CHINDEMI. *Chim. ind. agr. biol.*, **16**, pp. 576-577.—In order first to oxidise the organic matter, 5 c.c. of the molasses are diluted to a density of 1·10 to 1·16, 10 c.c. of 10 per cent. sodium hydroxide added, and the mixture heated on a boiling water-bath with 14 to 16 c.c. of hydrogen peroxide (approx. 100 vol.) for 60 to 90 mins. At the end of this time, the arsenic may be determined by one or other of the usual methods.

Electrical "Rabometer." S. K. MUKHERJEE. *Proc. 9th Conv. Sugar Tech. Assoc. India*, pp. 375-379 (with illustrations).—This instrument in principle is simply a thermometer the mercury thread of which actuates a signal when the cane juice being boiled in an open pan reaches the desired temperature.

[1] University College of Science, Calcutta.

[2] *I.S.J.*, 1940, p. 325.

Beet Factory Technical Notes.

Elimination of the Soluble Non-Sugars during Processing. A. R. NESS. *Proc. Amer. Soc. Sugar Beet Tech.*, 1940, pp. 298-304.

It has often been noticed that beets from adjoining territories give different results in the respective factories in which they were processed. Thus, in two Colorado districts both factories are of comparable size, have similar equipment and operate under similar conditions, yet one with poorer quality beets invariably obtained a higher elimination of non-sugars than the other, as measured by the purity of thin juice and molasses production. Below are average figures for the 5-year period immediately preceding the tests :—

District,	Sugar per cent Beets,	Apparent Purity Beets,	Apparent Purity Thin Juice,	Sugar in Molasses per cent Beets,
No. 1	15·30 ..	83·9 ..	88·8 ..	1·99
No. 2	15·80 ..	85·4 ..	88·8 ..	2·08

This investigation was undertaken to determine the reason for the difference. Apparent purities were run on daily composite samples of pressed, diffusion and thin-juice, and on colloid-free and diffusion juice. Daily samples were composited by weeks for more complete analysis, and corresponding composite samples of molasses were obtained. Analyses were also made on all weekly samples for total nitrogen, proteins, non-protein nitrogen, nitrate nitrogen and lixiviated ash. All results were reduced to campaign averages, the various non-sugars being expressed as lbs. per ton of beets. A discussion of the results obtained here follows :—

In regard to the composition of pressed juice, the total non-sugars in District No. 1 is 43·4 lbs., and in No. 2, 43·7, i.e., practically the same. The inorganic constituents are also the same, but there is a decided difference in nitrogenous compounds. Proteins, non-protein N compounds and nitrates are all higher in the beets from District No. 2 by 1·2, 1·3 and 0·5 lbs. respectively, and the non-nitrogenous organic compounds are lower by 2·9 lbs.

There is a reduction in the total non-sugar in diffusion juice as compared to pressed juice of 8·6 lbs. in No. 1 beets, and 4·6 in the No. 2 roots, a difference largely accounted for by an increase in ash. Comparison of diffusion juice with thin-juice shows the effect of liming and carbonatation on the removal of non-sugars. The most obvious point is that the thin-juice from No. 2 beets contains 3·1 lbs. more non-sugar than No. 1.

This amount of non-sugar will carry 3·6 lbs. of sugar into the molasses at 60° purity, increasing the sugar in the molasses 0·18 per cent. on beets. The reason for this difference in elimination lies in the fact that No. 1 beets contain a relatively large amount of non-nitrogenous compounds which are readily eliminated, while No. 2 beets contain a large amount of nitrogenous compounds which are not eliminated. This results in the production of lower purity thin-juice, and consequently a higher molasses production from No. 2 beets.

Beets No. 1 show 50 per cent. greater ash removal in colloidal form than No. 2. Again, the most marked difference is in the non-nitrogenous organic compounds, 40 per cent. of these being precipitated from the pressed juice of No. 2 roots, and 36 per cent. from No. 1. Some of these compounds in No. 2 beets are changed from the colloidal to the true solution state in the battery. Apparently, however, they are removed by lime, so that the net effect on the purity of thin-juice is negligible.

In regard to inorganic compounds, there is an increase in alkali compounds from pressed to diffusion juice, which of course carries through to thin-juice, due to the hydrolysis of alkali-organic compounds in the battery. In No. 1 beets both sodium and potassium are removed with the colloids. In No. 2 beets neither of these is removed, but instead an equivalent amount of magnesium is precipitated. Practically all of the Ca, Si, Fe and Al and about half of the P exist in colloidal condition.

It is apparent from these figures that 80 to 85 per cent. of the non-sugars in thin-juice are composed of two groups, inorganic and non-protein nitrogenous compounds. It is evident, therefore, that any improved method of juice purification will be successful only in proportion to its ability to remove these substances. Such a method will have to be a radical departure from the present one, probably a supplemental one, following the lime and carbonatation processes. Such a method is not impossible from a technical standpoint; it is the economic factors which will govern its application.

Sulphites in Beet Granulated Sugar. F. S. INGALLS. *Proc. Amer. Soc. Sugar Beet Tech.*, 1940, pp. 284-285.

An investigation was made of the factors controlling the amount of SO_2 in white beet granulated. Results from the initial survey made (when 100 grms. of the sample dissolved in 150 ml. of water were titrated with N/10 iodine solution) showed wide differences, not only as between plants, but also as between strikes at the same plant. These reaches a high of 170 p.p.m., and a low of 35. One plant, however, produced sugar generally falling within the lower range, and another quite uniformly made a product within the higher one.

A survey was commenced with samples from these two factories to cover the battery supply water, link gas, 1st and 2nd carb. juices, thin juices, thick

liquors and massecuites. Determinations made on the products up to the thin liquor failed to reveal SO_2 in any material quantity. However, in all cases the thin liquir carried a relatively heavy saturation of SO_2, pointing definitely to the fact that the presence of sulphites in the liquors is directly traceable to the use of sulphur dioxide in the process of manufacture.

Samples of thin liquor were analysed from seven of the operating factories (this being done by distillation, according to the official method of the A.O.A.C.). In general it was found that the degree of SO_2 saturation varied inversely with the *pH*, although a lack of correlation between the two led the author to suspect that a satisfactory control by the sulphites would involve regulation over the juices even before the addition of sulphur dioxide.

The next step involved study of the effect from changes in lime addition, alkalinity of the 1st carb. juice, *pH* of the 2nd carb. juice, and *pH* and SO_2 saturation of the thin liquor. Changes in lime addition where batch carbonatation was employed appeared to be a factor, and with all other values constant, sulphites in the granulated were found to be in the lower regions when the lime addition exceeded 2 to 4 per cent. CaO on the roots. Alkalinity of the 1st carb. juice when held within the limits necessary for proper filtration and sugar of normal colour, is definitely not a sulphite control feature.

Later data assembled showed that SO_2 concentration of the thin-juice reached its maximum when a relatively high *pH* in the 2nd carb. was sulphured to 7·4, which at that time was believed to be the low point in the tolerance limits of thin-juice. But the minimum SO_2 saturation was obtained when a relatively high *pH* in the 2nd carb. was sulphured to 8·6 *pH*. Sulphitation of 9·0 *pH* 2nd carb. to 8·5 *pH* in the thin-juice showed a somewhat higher SO_2 saturation of the thin-juice than did the 8·8 to 8·4 combination.

Control of the thin-juice to *pH* measurements falling within the region above 8·4 was at first viewed with some concern. Actually, however, colours have been generally better since these higher *pH* controls were adopted. Quoting values from the General Laboratory Report it is seen that the factory formerly showing SO_2 figures up to 170 p.p.m., now gives 7·7, while the factory previously returning 35 now reports an average of 4·9. *Conclusion*: Always assuming sufficient lime addition and 1st carb. normally performed, it will be found that further carbonatation during the 2nd stage on the high alkalinity side preceded by heat and carbonatated to 8·8 to 9·0 *pH*, followed by SO_2 saturation to 8·4 to 8·6 *pH*, will provide thin-juice from which sugar of relatively low SO_2 content may be expected.

Feed Value of Beet Tops. N. J. Muscavitch.[1] *Proc. Amer. Soc. Sugar Beet Tech.*, 1940, pp. 85-90.—Beet tops (leaves, stems and portion of the crown) were sampled at topping time, cured on drying racks, and analysed with the following results: Dry substance, 19·91; sugar (pol.), 4·24; crude protein, 2·63; crude fibre, 2·54; ash, 4·08; fat, 0·24; and nitrogen-free extract, 6·42 per cent. Dried beet tops are a source of nutrients approaching alfalfa in protein content. Feeding operations by investigators on the subject demonstrate their value in the replacement of a large proportion of concentrates and alfalfa in rations for fattening cattle and in the production of milk from dairy herd.

Sugar Losses in Beets in Storage. R. J. Smith.[2] *Proc. Amer. Soc. Sugar Beet Tech.*, 1940, pp. 286-289.—Beets were stored in the open in shovel and piler piles for periods varying from 25 to 51 days, and sampled from time to time, the average of all the analyses made being the following: Number of days in the pile, 39; moisture, per cent. roots, into pile, 76·59, out of pile, 75·93; sugar (pol.) per cent. roots, into pile 16·25, out of pile, 16·11; purity, into pile, 85·3, out of pile, 84·1. This gives an average sugar loss per ton of beets per storage day of 0·50 lbs. It should be possible to reduce these losses by observing the following precautions: Frosted or diseased roots should be kept out of the storage piles, only clean, trash-free and mature roots being stored; and some means should be adopted of lowering the temperature of the pile, practicable in large scale operation.

Rat Control.—Further study by the Hawaiian Experiment Station[3] of poison bait acceptance by field rats confirms confidence in thallium sulphate; but to obtain the best results it was found necessary that the "pre-bait period" of feeding with unpoisoned material as rolled oats should be followed by an abrupt change to the thallium-treated rolled oats. When this was done it was found that the acceptance of the thallium bait was twice that of barium bait. Acceptance in the case of red squill was very poor.

A New Jute Substitute.—Among the new fibres produced as substitutes for jute, ramie, hemp, etc. is the "Hofa," which consists of wood fibre stock and viscose, the latter serving as binder. It is said to resemble horse hair.[4]

Vitamins in Molasses.[5]—In addition to its energy-giving qualities, molasses has been found to be a rich source of iron and calcium, the minerals commonly lacking in some diets; and also of several vitamins of the *B*-complex, which are associated in nature with plant carbohydrates. Its iron is mostly in a form readily assimilable by the human body. Even high-vitamin brewer's yeast, widely used in medicine as a concentrate of the vitamin *B*-complex is preferentially grown on a nutrient rich in molasses from which the yeast can absorb or synthesize biotin, pyridoxin and other minor members of the *B*-complex.

1 Great Western Sugar Co. 2 Holly Sugar Corporation.
3 *Report of the Committee in Charge of the Experiment Station, Hawaiian S P A.*, 1940, pp 92–94. 4 *Current Science*, 9, No. 12.
5 *Industrial Bulletin* of Arthur D. Little, Inc., No. 171, July, 1941.

New Books and Bulletins.

Active Carbon: The Modern Purifier. JOHN W. HASSLER. (Industrial Chemical Sales Division, West Virginia Pulp and Paper Co., 230, Park Ave., New York). 1941.

This is the second edition of a useful small book giving much information on active carbon in general and on "NuChar," an American product, in particular. It tells the reader in non-technical language what active carbon really is, how it is manufactured, and to what its remarkable qualities as an adsorbent are to be attributed. It describes its many applications outside the sugar industry, as in oil refining, the treatment of wines and spirits, the purification of many chemicals, and in industries as far apart as electroplating and gold extraction. It gives particulars of methods of evaluation and on the theory of adsorption. There is a very full bibliography to which is appended a list of authors' names. Under the heading of "Commercial Active Carbon," data are given on the several types of "NuChar" on the market today, the specification of each, and the uses to which each may be put. It is well written, and gives a great amount of information, clearly expressed, on a product which has become of much interest in its rôle of "the modern purifier."

Manual of Sugar Companies, 1941. (Farr & Co., 90 Wall Street, New York). 204 pp. Price $1·00.

This is the 19th edition of an annual issued by a leading firm of New York sugar brokers. It contains the chief statistics and particulars of all the leading sugar companies within the American zone, plus a few world-famous firms in other countries. There are also summaries of information about the sugar countries concerned and their factories are listed, including the British West Indies. New York market practice is outlined and there are reproductions of the Nos. 3 and 4 Contracts for the enlightenment of those not directly concerned with them. A lot of miscellaneous information and a liberal number of statistical tables are included in the annual, which will be found of use to all those studying the commercial aspects of the sugar industry in the North Americas.

Plastics. V. E. YARSLEY and E. G. COUZENS. Pelican Books, No. A-80. (Allen Lane, Harmondsworth, Middlesex; and New York). Price 6d. 1941.

This small book is being read in large numbers by those desiring to obtain information on plastics, the prodigy industry of our age. It lacks nothing in the way of clearness in the technical information it conveys. It explains what plastics are, and why plastics are plastic. It describes the manufacture of plastics, and the mechanical processes that are used in their formation. It concludes with a chapter on "Plastics and the Future," and contains 24 excellent plates. Attention is here drawn to it in view of the interest that is being taken in "Plastics from Bagasse," which project offers much in the direction of the profitable utilization of one of the by-products of our industry.

Chemical Engineering Catalog, 1941-42. REINHOLD PUBLISHING CORPORATION, New York. 26th Edition. Price: $4·00 (outside the U.S. and Canada, postage extra). 1941.

This, the latest edition of "the Process Industries' own Catalog," retains the same useful features as the last. It consists of "condensed and standardized data on equipment, machinery, laboratory supplies, heavy and fine chemicals, and raw materials used in the industries, with classified indexes of such equipment and materials, carefully cross-referenced, and including also a technical and scientific books section, briefly describing a practically complete list of books in English on chemical and related subjects." It also contains a "Trades Names Index" and a "Technical Data Section," this latter comprising a humidity chart for air and water, nomographs for the conversion of wet and dry bulb readings to humidity units, data on multiple V-belt drives, size distribution and surface area chart, information on simple tests for identifying metals, properties of standard refrigerants, chart giving the discharge of water through smooth pipes, orifices and valves, a table giving the power consumed pumping 1000 gallons of clear water at 1 ft. total head, etc., etc. As we have remarked before when dealing with previous editions, it is a remarkable compilation, of the great value of which to those dealing with the U.S. in machinery or chemicals, there can be no doubt at all.

The Chemical Formulary. Volume V. Editor-in-Chief, H. BENNETT. (Chapman & Hall, Ltd., London) 1941. Price: $6·00.

Sufficient new formulae have been gathered to compile another edition of this book, an addition which will bring up-to-date the contents of the first four volumes.[1] This collection of trade recipes and manufacturing data, the reliability of which is guaranteed by the Board-of-Editors of prominent chemists, is a most useful one. Far from being composed of a mass of formulae, it really consists of a large and varied amount of manufacturers' information, much of which has not heretofore been published. This volume will make a valuable addition to any reference library.

[1] *I.S.J.*, 1940, p 182.

British Sugar Corporation.

The annual accounts of British Sugar Corporation Ltd., for the year ending March 31st, 1941, were issued last month, after a longer interval than usual due to an enforced change in accounting procedure. The trading profit for the year is given as £777,164 (as against £772,143 in 1939-40). After deducting certain prior charges, including £210,000 for depreciation, £80,000 for War Damage Act contribution, and £151,000 for taxation reserve, a balance remains of £124,236 which with £42,514 brought in makes a total of £166,750 as available balance. An interim dividend of 4½ per cent. (less tax) was paid last August, absorbing £112,500 and the sum of £54,250 carried forward.

The Government have decided that during the War period a deficiency payment, calculated on a basis which will give a reasonable return to the Corporation on its capital, shall be substituted for the rate of assistance based on a forecast, as laid down in the Sugar Act of 1936. The "reasonable rate" allowed by the Treasury for the year 1940-41 is 3½ per cent. This compares with the 4 per cent. assumed under the 1936 Act. Under the latter there was an understanding that the Treasury would provide assistance sufficient to assure an annual basic return of 4 per cent. on the Corporation's capital, a return which in practice could be increased through the revenues retained under the "incentive" agreement; that is, a proportion of the economies accruing from the amalgamation of the original 15 factories.

It would have been impossible under wartime conditions to make the necessary calculations prescribed in the Sugar Act which, for practical purposes, has been suspended for the period of hostilities. As it is, the Corporation's share of the economies under the profit sharing scheme has been sufficient to provide out of revenue a contribution of £80,000 for the War Damage Act and to pay in dividend 1 per cent. over the basic rate allowed by the Treasury. A sum of £105,000 not now required has been transferred from taxation reserve to duty changes reserve, bringing the latter up to £180,000, which is deemed adequate to provide against eventual losses arising from any subsequent fall in the sugar duty.

The death of two directors of the Corporation is mentioned, in the persons of Mr. J. N. Mowbray and Mr. H. E. Carter, both of whom were pioneers of the home beet sugar industry. Mr. Mowbray was born in Canada 62 years ago, where he gained experience with the Dominion Sugar Company. In 1925 he formed the Central Sugar Company which erected the Peterborough sugar factory in this country, and in 1926 followed it up with the Yorkshire Sugar Company, which built the Selby factory.

Sir Alfred Wood, who has been associated with the beet sugar industry from its first introduction into this country resigned his position as secretary of the Corporation last August and has since been elected a Director.

Correspondence.

Sugar Cane Fibre.

To the Editor,

"The International Sugar Journal."

Dear Sir,

May I make a few observations in reply to the article on "Sugar Cane Fibre" by G. C. Dymond which appears in your November issue (page 342).

That fibre is a general and not a specific term is well recognized, and in the cane there can be at once distinguished two materials of widely variant physical properties, the scelerenchyma or rind tissue, and the parenchyma or pith. I showed many years ago[1] that the latter material leaves the mill much more exhausted than does the former and it follows then that a cane with a higher proportion of parenchyma will tend to afford higher extraction figures than when the proportions are reversed. The reduced extraction formula was presented with full knowledge of this condition, which is one that is not open to expression in the algebraic formula.

That, however, this condition when expanded by Mr. Dymond into the factor of Varietal Quality invalidates the principle of the formula cannot be accepted. With the principle it has nothing to do. If, however, Mr. Dymond had written that the new factor of Varietal Quality limited the scope of the reduced extraction formula I would not gainsay his statement.

It may be further pointed out that the "verloren sap" of Java and the reduced extraction formula are mutually interdependent and that invalidation of the latter equally negatives the use of the former.

Yours faithfully,

NOËL DEERR.

Java Exports of Sugar.—During the first seven months of 1941 the exports of sugar from Java, amounting to 517,134 long tons raw value, were practically the same as in the like period of 1940. But 80 per cent. (as against 61 per cent.) went to Asia and Africa, and 18 per cent. (as against 37 per cent.) to Europe. On August 1st, 1941, stocks, according to Lamborn & Co., were 937,526 long tons as against 671,230 tons at the same date of 1940. The 1941 harvest, which has just terminated, has been estimated at 1,695,000 long tons, as against 1,579,697 tons turned out last year.

[1] H.S.P.A. Ex. Sta. Bull. 43.

Sugar-House Practice.

Economic Steam Production and Consumption in Mauritius Factories. L. J. COUTANCEAU. *Revue agricole*, **20**, No. 1, pp. 7-16.

This is a paper offering advice to Mauritius sugar factory staff on "how to produce steam economically, reduce to a minimum the steam consumption, and avoid the wasting of steam in the different departments of our sugar factories." Its calculations assume a 12½ per cent. fibre in cane, a 24½ bagasse in cane, and a bagasse containing 51 per cent. of fibre, 3 per cent. of sugar, and 45 per cent. of moisture.

In those factories making white sugar, the bagasse of 12½ per cent. fibre in cane is barely sufficient, and even some sugar factories find it necessary to burn wood. During the past 15 years or so, a number of the factories have done much towards remedying this defect. Others (presumably through insufficient capital) have not been in the position to effect many improvements. Steam consumption figures per ton cane per hour are 750 and 625 kg. for white and raw houses respectively.

Owners should realize "how indispensable it is to instal in their factories a Lea Recorder in order not only to control the steam consumption, but to allow those in charge to detect and alter the faulty departments." This is not a costly apparatus, and is "a great help towards standardizing the general arrangement of sugar factories for the great variety of sugar cane which they have to crush."

Factories with multitubular boilers lose some 7 per cent. (say 50 kg. of steam per ton cane per hour) through condensation in the steam piping and engines, which loss naturally is greater when such boilers are overloaded and are producing wet steam. Multitubulars cannot be so easily fitted with superheaters as can water-tube boilers.

Formerly the heating and evaporating of the juice were performed separately; but during recent years most Mauritius factories now feed their open or high velocity heaters with vapour bled from the first or second effects of the evaporator. Yet there are not many of them whose juices reach 92°C. before flowing into the defecators, the reason for this being that the existing evaporators were not designed to take this modification, or else have been overloaded since the factory has taken up the manufacture of raw sugar. This means that juice heated only to 70 to 85°C. has to be raised to "cracking" temperature in the defecators, this adding unnecessarily to the total steam consumption.

Calculations made by the author to illustrate the above assume a quantity of 1000 kg. of juice per hour (i.e., the juice from one ton of cane per hour with 33·3 per cent. dilution). When (1) *The juice is heated and evaporated separately*, the steam to raise it from 28 to 92°C. is 110 kg.; that to evaporate 75 per cent. by weight of it in a triple would be 300 kg., per hour, a total of 410 kg.; that to evaporate in a quad to the same degree would be 240 kg., i.e., a total of 350 kg. When (2) *The juice is heated by vapour bled from the evaporators, and also evaporated to the same degree*, then the figure for a triple is 350 and for a quad it is 300 kg.

As mentioned before the author thinks it is only through lack of capital that it has not been possible to correct the defects indicated, but he remarks that it would certainly have been a great benefit to have altered the heating and evaporating sections, i.e., where the greatest saving in the cost of extra fuel would in a very short time have compensated the cost of the installation.

Pure Yeast Machine for the Distillery. DOMINADOR E. BATENGA.[1] *Sugar News*, **21**, pp. 303-304.

MAGNÉ[2] stipulates that the two principal requirements of a good pure yeast apparatus are that: (1) it must produce the yeast in as pure a condition as possible, continuously, and at its maximum activity; and (2) the size must be in proportion to the amount of wort fermented in the distillery per day. In this article the author describes a machine cheaply constructed by him, which is claimed to meet these requirements.

It consists of the following parts: (1) a 20-gallon copper vessel (made of an old coffee urn) containing the pure yeast reserve to seed two larger vessels. These two cultivators have a capacity of about 150 gall. each, used alternately in seeding two prefermenters holding about 2500 gall. each, which in turn seed the main fermentation vats. An air filter (made from an old oil feed cup) filled with sterilized cotton is used for the purification of the air that comes from the compressor.

A washing apparatus is also provided, consisting of a 3 in. copper pipe, which bubbles the air through a solution of copper sulphate before it goes to the 20 gall. copper vessel and the two 150 gall. cultivators. Further, there is a syphoning device for seeding the cultivators; a ¾ in. copper coil inside the 20 gall. copper vessel for cooling; and a ½ in. perforated tube connected outside the two 150 gall. cultivators.

There are also outlet tubes for the CO_2 which discharge into a vessel filled with an antiseptic solution, and inlet tube for the first pure yeast used in starting the apparatus, an aerating device, and suitable piping systems for the wort and steam. Then the apparatus is also provided with a separate heater (made from a 50 gall. alcohol drum, fitted with steam coils) for sterilizing the wort, and a 5 gall. tank to supply the sterilized cooled wort for the 20 gall. copper vessel.

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[1] Distillery Chemist, Paniqui Sugar Mills, Philippine Islands.
[2] In his pamphlet "The Manufacture of Alcohol from Cane Juice and Molasses."

Operation with this pure yeast machine is simple, but as with any other such apparatus due care to ensure sterile conditions are necessary. Previous to putting it into use, the Magné yeast used was cultivated in open fermenters and cut from one vat to another, but unsatisfactory results were obtained. As may be seen from the figures given below, the pure yeast machine was the means of increasing from 60·18 to 78·95 the actual yield of 95 per cent. alcohol per cent. theoretical yield. An imported pure yeast machine would have cost about ten times as much.

	Without pure yeast machine.		With pure yeast machine.
Final molasses fermented, litres ..	121,976	..	124,623
Final molasses fermented, kilos ..	176,191	..	181,650
Total fermentable sugars, kilos ..	101,705	..	98,730
Theoretical absolute alcohol, litres	61,022	..	60,225
Actual recovery, G.L.	36,720	..	47,550
Litres molasses per litre alcohol	3·32	..	2·62
Actual yield of 95 per cent. alcohol per cent. theoretical yield	60·18	..	78·95
Molasses Analyses :			
Brix	84·68	..	86·60
Sucrose (Clerget)	39·49	..	34·78
Reducing sugars	26·33	..	26·73
Brix of wort	14·56	..	13·51

Use of Electric Cranes in Sugar Mills. North Queensland Institute of Sugar Technologists. *Proc. Queensland Soc. Sugar Cane Tech., 12th Conf.*, pp. 147-148.

Only those mills which have already changed over from a manually operated crane over the crushing section of their plant to one electrically driven can fully appreciate the great benefits which ensue. At South Johnstone, the time taken by three men to move the old hand crane the full length of the travel was 20 minutes. After electrification of the crane in 1921, one man, in a control cabin, could accomplish the same travel in two minutes. Again, where it required eight hours to lift a roller from a railway truck and place it on the floor at the far end of the building, the electric drive did it in 12 minutes, with less than half the labour previously required. The 20-ton crane installed in 1939 is even more effective as regards time saving.

Not only is there a considerable saving in labour, but the increased speed of operation is most noticeable. This particularly applies when it becomes necessary to change shredder shafts, due to cracked or broken discs or when new pusher ropes have to be placed in service. Again, during overhaul periods, where previously it was the practice only to lift and pack many of the rollers so that the brasses could be removed, it is now the custom to strip the mills completely, the rollers being removed and set aside, thus facilitating inspection and overhaul of plant.

One fallacy which has possibly delayed the installation of electric cranes in certain mills was the belief that A.C. was unsuitable for their operation ; actually, it is just as adaptable for this purpose as D.C. It does require a few extra supply conductors and collectors, but the cost of these is more than compensated by the lower costs of A.C. motors as compared with D.C.

There is, however, one important question which, it appears, has so far been entirely overlooked, and that is whether there are any special conditions in sugar mills which might affect the successful operation of standard electric installations. Such a condition does exist in the form of fine particles of bagasse (carried upwards from the knives, the shredder, and the various mills) which collect on the electric conductors and on all portions of the crane frame.

Results are twofold, firstly the film of bagasse around the conductors insulates them from the collector wheels and the motors refuse to operate. Secondly, the film around the insulation of the many collector wheels supports allows current to flow to the steelwork of the carriage. Also bagasse, usually of a drier nature, covers the rails and main girders on which the carriage moves, and the carriage thus becomes more or less insulated from earth ; shocks are then received by anyone touching the lifting hook.

In tests on the 20-ton crane at South Johnstone the former was found as low as 25,000 ohms and the latter as high as 80,000 ; under these quite extreme conditions a shock of about 180 volts would be received by a person touching the hook. On both the crane installations at South Johnstone it was necessary, for a period, to clean all conductors of bagasse before operating the cranes. Eventually the collector wheels were replaced by shoes which automatically cleared the bagasse off as they moved along the conductors, and the carriages were earthed with steel brushes which make permanent contact with the main frame. In at least one other mill an additional conductor was added by which the carriage has been connected to earth. Both methods are effective in overcoming the danger of shock.

Regularity or Irregularity. J. P. van Gennep. *Archief Suikerind. Nederl.-Indië*, **1**, pp. 288-290.—On comparing work in the modern sugar factory at the present time with what it was formerly, one is impressed with the effort to carry out operations continuously, that is, with "regularity" as the basic principle. Great possibilities exist in continuous juice purification processes, and much yet remains to be done at the pan boiling station. At present there are two possible methods of working there : (1) Boiling so as to ignore the regularity of the grain of the massecuite, the seed grain being later separated by sifting ; and (2) boiling the grain of the massecuite uniformly, a special strike being boiled now and again so as to provide the "seed" grain. Method (1) is an example of irregular working, as generally much more fine grain is available for "seed" than is required, and

the result is the capacity of the pans is decreased. Method (2) on the other hand is a step towards regularity, as it at once gives an even-grained sugar which purges readily and in consequence uses little water in its washing, finally giving a better yield.

Preparation of Edible Vinegar from Saccharine Juices.[1] J. P. SHUKLA.[2] *Proc. 9th Conv. Sugar Tech. Assoc. India*, I, pp. 347-363.—Stages in the production of vinegar are: preparation of the saccharine juice using molasses, sugar, *gur*, honey or fruit juices; fermentation of the sugars to alcohol by yeasts; the conversion by the bacterium *Mycoderma aceti* of the alcohol to acetic acid, and the "finishing" of the vinegar, i.e., its flavouring, storing with the development of flavour, and (if necessary) its filtration.

Potash Alum from Molasses. D. G. WALAWALKAR.[3] *Proc. 9th Conv. Sugar Tech. Assoc. India*, I, pp. 361-363.—A description is here given of the alum process for the separation of potash from cane molasses,[4] believing that, "if the demand for this alum increases owing to the establishment of paper and other industries using it, a trial should be given to it. Alumina ferric or crude aluminium sulphate is now made in India. However, it is admitted that the difference in price in favour of potash alum as compared with aluminium sulphate is only Rs. 2 per cwt.

Making Sugar for Refining. G. L. PACK. *Chem. & Metall. Eng.*, 1941, **48**, pp. 77-79.—This is a general description written for the benefit of chemical engineers of the modern New Iberia sugar factory, Louisiana, by its manager. He lays emphasis on improved details of plant design and construction. In this plant liberal use is made of stainless steel for limiting corrosion and abrasion.

Plate Efficiency Study in Alcohol Distillation. LEONARD BYMAN and D. B. KEYES. *Chem. & Metall. Eng.*, 1941, **48**, pp. 85-87. -This article is an abstract of Bulletin No. 328, of the University of Illinois Engineering Experiment Station, and gives the results of an investigation of the effect of certain factors on plate efficiencies in the distillation of alcohol-water mixtures. Factors considered include vapour velocity, liquid rate and composition of the system. A semi-quantative analysis of the probable effect of viscosity, surface tension and diffusional driving force was also made.

Evaporation Nomograph. D. S. DAVIS.[5] *Ind. & Eng. Chem.*, 1941, **33**, p. 319.—A nomograph has been constructed to give the lbs. of water evaporated per lb. of solids of thin liquor, using the following expression, in which s is the solids in the thin liquor, and S the solids in the thick liquor:

$$\left(\frac{100-s}{s}-\frac{100-S}{S}\right)s=100\left(\frac{S-s}{S}\right)=100\left(1-\frac{s}{S}\right)$$

The Sandvik Steel Belt Conveyor. A. WIESLANDER. *Archief Suikerind. Nederl.-Indië*, 1941, **1**, pp. 572-588. —It is made entirely of steel, and experience in European factories leads the author to recommend it for the transport of sugar bags. It is lighter and requires less power to operate compared with types made of other materials. Repairs are quickly made with spare parts and are inexpensive in labour and materials.

Keeping Qualities of Indian Sugars. A. NAGARAJA RAO and U. S. SAHAY.[6] *Proc. 9th Conf. Sugar Tech. Assoc. India*, I, pp. 225-237.—Work done on Indian sugars enable the authors to draw the following conclusions: "Different sugars absorb different amounts of moisture, even at the same temperature and humidity, the sugars which are deteriorating absorbing more than the others. The sugar sample which has kept the best is the least hygroscopic at all different humidities and temperatures. With lowering in humidity, moisture absorption falls off almost to zero. Sugars of different crystal size absorb different amounts of moisture, the percentage absorbed being greater with the smaller than with the larger crystals. Grain for grain at 100 per cent. humidity, alcohol-washed samples absorb more moisture than dried samples, although with lowering in humidity the absorption by these sugars becomes less than by the dried sugars......Moisture absorption by dried sugars is greater at lower than at higher temperatures......"

Sugar Boiling in the Presence of Manganous Sulphate. KAKUO SUKUKI. *J. Soc. Chem. Ind.* (Japan), **43**, suppl. p. 234-235.—Claim is made by this author that the presence of a minute quantity of $MnSO_4$ has the effect of shortening the time taken for boiling, of increasing the yield, and of largely avoiding the formation of false grain.

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1 See *I.S.J.*, 1932, p. 43, an article by C. A. COPPIN, who described the manufacture of vinegars from cane juice, which were bright, of excellent flavour, and of good keeping qualities, quite suitable for domestic table use. 2 Imperial Institute of Sugar Technology, Cawnpore. 3 Imperial Institute of Sugar Technology, Cawnpore. 4 See NEWLANDS' "Sugar" (1909), p. 509. The alum process was intended for application to beet syrups and molasses particularly rich in potash. 5 Wayne University, Detroit, Mich. 6 Imperial Institute of Sugar Technology, Cawnpore.

Review of Recent Patents.

Copies of specifications of patents with their drawings can be obtained on application to the following—*United Kingdom:* Patent Office, Sales Branch, 25, Southampton Buildings, Chancery Lane, London, W.C.2 (price 1s. each). *United States:* Commissioner of Patents, Washington, D.C. (price 10 cents each).

UNITED STATES.

Vertical Crystallizer and Vacuum Pan. JOHN E. STUNTZ, of Cinclare, La., U.S.A. 2,230,768. February 4th, 1941.

In the preamble to this specification, some of the requirements to be met by a vacuum pan are stated, viz.: The sq. ft. of heating surface must be twice the volume of product treated. This h.s. must be evenly distributed. The mass must be kept in circulation. The heating units should be easily accessable for cleaning inside and outside, and each must be capable of removal without disturbing any other parts. Non-condensible gases and condensate must be removable continuously.

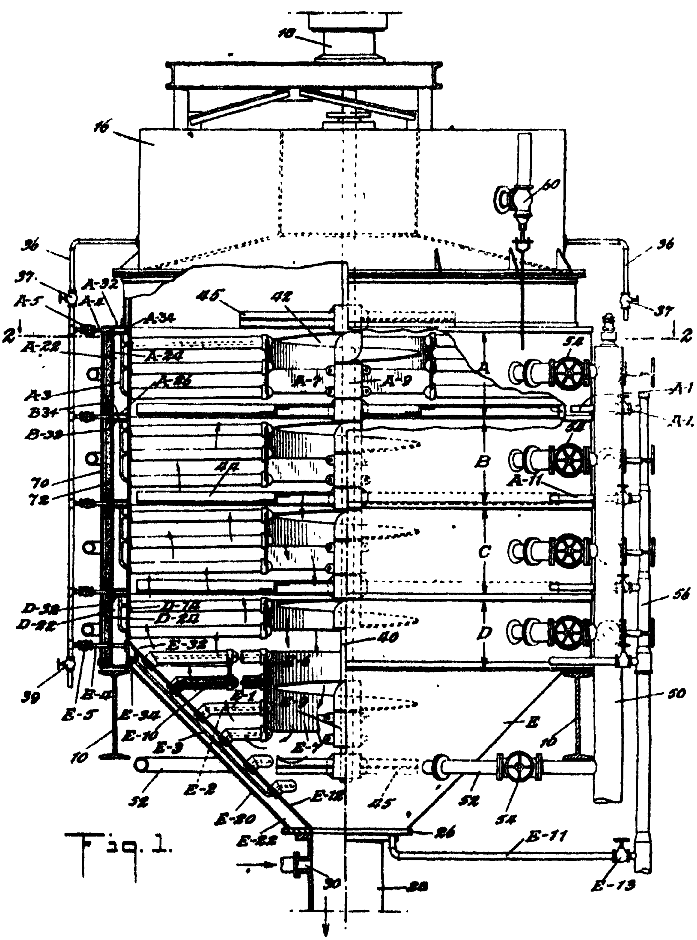

Fig. 1.

Then, another object of this invention is to incorporate the crystallizer into the vacuum pan, so that the total cycle of boiling and crystallizing may be performed in less time, with greater efficiency, and with less apparatus than with a separate vacuum pan and crystallizer. Yet another object is to provide an apparatus which can be made up in sections easy to handle, yet of rugged construction, the parts of the sections being duplicates, so as to reduce as far as possible the cost of manufacture.

In the drawing is produced an example, this being a front elevation view partly in section of the combined vertical vacuum pan and crystallizer constructed according to the principles of the invention. Claim 1 reads: A combined vacuum pan and crystallizer comprising a container having a plurity of tubular members projecting inwardly from the wall of the container forming heat-transferring surfaces in positions to occupy uniformly substantially the whole of an annular centrally-open section so as to form a labyrinthine passage around a free central passage for the sugar bearing materials, and mechanical propelling devices mounted to cause the sugar bearing material to flow in one direction through said central passage and in the opposite direction through said labyrinthine passage.

Claim 2: A combined vacuum pan and crystallizer comprising a plurality of identically functioning sections joined together, each section comprising a continuous side wall, a plurality of individual unitary uniformly distributed U-shaped pipe coils forming heat-transferring surfaces extending inwardly from said wall, means forming a separate duct around each sectional wall and communicating with each heating unit, means individual to each section to vent each heating unit thereof, and means to remove condensate from each section individually, and steam supply means connected with each of said encircling ducts separately, and means in said connexions for controlling the supply of steam to each individual section, whereby the admission of steam and the venting of incondensible gases and the removal of condensate

may be accomplished for each section separately, and means for each individual section to control the functioning and operation of the individual elements thereof whereby each section may function alone or conjointly with the others.

Preparing Activated Carbon. RAYMOND G. DAVIS, of Bellevue, Del. 2,245,579. June 7th, 1941.—Claim is made for: A process comprising heating cellulosic material with more than an equal weight of an activating agent selected from the group consisting of phosphoric acid, sulphuric acid, and zinc chloride, leaching the activating agent from the carbon with water, said heating being conducted at a relatively low temperature and for a period of time such that the carbon has high activity prior to the substantial removal of the leaching water but loses its activity rapidly when dried at temperatures above room temperature, the activity approaching zero when the carbon is so dried completely, contacting the carbon while still containing a large amount of the leaching water with a water-miscible, readily volatile organic solvent for a period of time sufficient to displace and dissolve water from the carbon, separating the resulting solution of the solvent and water from the carbon, maintaining the temperature at a value not substantially above room temperature during said contacting and separating steps, and thereafter evaporating the residual volatile solvent from the carbon.

Multiple Unit Filter. EUGENE J. CANTIN, of New York. 2,220,706. November 5th, 1940.—Claim is made in a filtering apparatus for the combination of a plurality of separate distinct and severally complete filtering cells each provided with a body of filtering material, a common source of fluid to be filtered adapted to deliver the same under pressure to the cells, a common discharge receptacle receiving the filtrate from all of the cells, and means for utilizing the pressure of the incoming fluid to effect delivery thereof to the filtering cells in succession, the said means including pressure responsive elements associated with said source of fluid and actuated by back pressure in a clogged cell to which the fluid is flowing to deliver the fluid to another cell through which the flow is comparatively free.

Producing Mouldable Lignocellulose. ARLIE W. SCHORGER and JOHN H. FERGUSON (assignors to BURGESS CELLULOSE CO., of Freeport, Ill., U.S.A.). 2,247,204 to 2,247,210. June 23rd, 1941.—Relate to processes of forming thermoplastic lignocellulosic compositions capable of being moulded under heat and pressure into hard, resinous products, comprising, for example, water-cooking a sub-divided natural lignocellulose for less than three hours at a temperature of approximately 185 to 200°C. in the presence of an alkaline substance having a water-solubility of at least 1 per cent. at 100°C. to form a thermo-plastic product.

Decolorizing and Filtering Agent. RICHARD W. SCHMIDT (assignor to THE DICALITE CO., Los Angeles, Cal., U.S.A.). 2,219,581. October 20th, 1940.—Claim is made for the method of producing a decolorizing and filtering agent which comprises: coating the particles of a finely divided diatomaceous earth filter-aid with a carbonizable organic adhesive; cementing minute preformed particles of a finely comminuted carbon selected from the group consisting of the vegetable chars and the soot carbons to the surfaces of said earth particles by means of said adhesive coatings; subjecting the mixture to carbonization, and activating the carbon contained in the carbonized mixture by contact at elevated temperature with a mild gaseous oxidizing agent.

Filter-Medium. ERNEST J. SWEETLAND, of Piedmont, Cal., U.S.A. 2,243,296. May 27th, 1941.—Claim 1: A method of making a filter-medium which comprises impregnating a fibrous material with an alkaline silicate, and then treating with a chemical having a metallic base.

Treating Candy Scrap. ALBERT C. ROLAND (assignor to APPLIED SUGAR LABORATORIES, INC., of New York). 2,227,813. January 7th, 1941.—Claim 2: The process of reclaiming candy scrap which comprises dissolving in water to make a syrup, treating with an alkaline earth hydroxide and a precipitant at a temperature of approximately 180°F., filtering the resulting mixture with about 1 per cent. of activated carbon at a temperature of about 160°F. to remove the excess chlorine, and then filtering the mixture.

Desiccating Apparatus (for Molasses, etc.[1]). DAVID D. PEEBLES (assignor to GOLDEN STATE CO., LTD., of Delaware, U.S.A.). 2,240,854. May 6th, 1941.—Claim is made is a desiccating apparatus (for molasses, etc.) for a treatment chamber having an outflow conduit for the removal of desiccated material entrained with drying gas introduced into the chamber, means for maintaining swirling movement of gas within the chamber, and baffle means within said chamber disposed adjacent the point of communication of the chamber with said conduit, for minimizing the swirling of gas and entrained material.

Stimulating Fermentation. A. L. SCHULTZ, L. ATKIN and C. N. FREY (assignors to STANDARD BRANDS, INC., of New York). 2,249,789. July 22nd, 1941.—Claim 9: A method for determining the vitamin B_1 content of a material, which comprises preparing a solution containing dextrose and an ammonium phosphate, adding yeast thereto and incorporating a vitamin B_1 containing a material therewith, allowing fermentation to proceed substantially without yeast growth for a given period of time with agitation, determining volume with that arising from a like fermented solution to which vitamin B_1 in definite amount has been added.

[1] See *I.S.J.*, 1940, p. 189.

Stock Exchange Quotations of Sugar Company Shares.

LONDON.

Company.	Quotation November 20th 1941		Quotation October 20th 1941		1941 Dealings Highest.	Lowest.
Anglo-Ceylon & General Estates Co. (Ord. Stock) ..	27/6 — 28/9	..	25/9 — 26/9	..	27/6	— 23/9
Antigua Sugar Factory Ltd. (£1 Shares)	½ — ¾	..	½ — ¾	..	11/6	— 8/9
Booker Bros., McConnell & Co. Ltd. (£1 Shares)....	$2\frac{9}{16}$ — $2\frac{11}{16}$	..	2½ — 2⅝	..	52/6	— 47/6
Caroni Ltd. (2/0 Ord. Shares)	1/6 — 2/0	..	1/6 — 2/0	..	1/9	— 11½
(6% Cum. Pref. £1 Shares)	22/6 — 23/6	..	21/3 — 22/3	..	23/0	— 20/3
Gledhow-Chaka's Kraal Sugar Co. Ltd. (£1 Shares)..	$1\frac{3}{16}$ — $1\frac{5}{16}$	..	$1\frac{3}{16}$ — $1\frac{5}{16}$	..	24/6	— 22/0
Hulett, Sir J. L. & Sons Ltd. (£1 Shares)	25/9 — 26/9	..	26/9 xd 27/9	..	29/4½	— 22/1½
Incomati Estates Ltd. (£1 Shares)	$\frac{3}{16}$ — $\frac{5}{16}$	..	⅛ — ¼	..	4/1½	— 3/6
Leach's Argentine Estates Ltd. (10/0 units of Stock)	8/9 — 9/9	..	7/9 — 8/6	..	8/6	— 5/0
Reynolds Bros. Ltd. (£1 Shares)	37/6 — 39/6	..	36/0 — 38/0	..	38/3	— 32/7½
St. Kitts (London) Sugar Factory Ltd. (£1 Shares) ..	1⅝ — $1\frac{7}{16}$	..	1⅝ — 1⅞	..	35/0	— 34/3
Ste. Madeleine Sugar Co. Ltd. (Ordinary Stock)	15/9 — 16/9	..	15/6 — 16/6	..	16/9	— 11/9
Sena Sugar Estates Ltd. (10/0 Shares)	5/10½ — 6/4½	..	5/10½ — 6/4½	..	6/6	— 4/0
Tate & Lyle Ltd. (£1 Shares)	61/3 — 62/3	..	58/0 — 59/0	..	60/3	— 46/0
Trinidad Sugar Estates Ltd. (Ord 5/0 units of Stock)	5/9 — 6/3	..	5/6 — 6/0	..	6/0	— 5/0
United Molasses Co. Ltd. (6/8d. units of Stock)	31/9 — 32/3	..	26/9 — 27/3	..	32/6	— 21/9

NEW YORK (Common Shares).†

Name of Stock.	Par Value.		Closing Price October 31st, 1941.		1941. Highest for the Year.		Lowest for the Year.
American Crystal Sugar Co.	No par	....	17⅞	..	19½	..	9½
American Sugar Refining Co.	$100	....	19	..	22⅛	..	13
Central Aguirre Associates	No par	....	16¾	..	22¾	..	15½
Cuban American Sugar Co.	$10	....	7	..	8½	..	3½
Great Western Sugar Co.	No par	....	23¾	..	28	..	19⅞
South Puerto Rico Sugar Co.	No par	....	17⅜	..	21	..	13

† Quotations are in American dollars and fractions thereof

United States, All Ports.

(Willett & Gray)

	1941 Long Tons.		1940 Long Tons.		1939 Long Tons.
Total Receipts, January 1st to October 11th	3,883,814	....	3,031,070	....	3,278,503
Meltings by Refiners ,, ,, ...	3,785,872	....	3,070,511	....	3,170,585
Importers' Stock, October 11th	102,942	....	76,605	....	46,706
Refiners' Stock ,, ,, ...	261,695	....	320,523	....	261,194
Total Stock ,, ,, ...	364,637	....	397,128	....	307,900
	1940		1939		1928
Total Consumption for twelve months	5,712,587	....	5,648,513	....	5,604,051

Cuba.

(Willett & Gray)

	1941 Spanish Tons.		1940 Spanish Tons.		1939 Spanish Tons
Carry-over from previous crops	1,184,393	....	588,293	....	729,172
Less Sugar for Conversion to Molasses	80,941	....	— —	....	— —
	1,103,452	....	588,293	....	729,172
Authorised Production	2,399,004	....	2,753,903	....	2,696,517
	3,502,456	....	3,342,196	....	3,425,689
Exports since January 1st	2,476,450	....	1,791,514	....	2,237,580
Stock (entire Island) October 11th	1,026,006	....	1,550,682	....	1,188,109

The Market in New York.

There has been a further advance in the No. 4 World Futures Contract during the period under review with quotations reaching new high levels particularly in the more forward positions where these have again assumed a premium over prompt delivery. Although in the past the incidence of separate quotas for the United States and the world markets has meant different viewpoints being necessary in arriving at the respective value of each, the greater demand for Cuban sugars for reasons previously explained has resulted in the two markets again becoming inter-related.

Anticipations that the U.S. duty on Cuban sugar will be reduced to 0·75 c. are running very high whilst there are now reports that an increase in the maximum price is imminent; also that the United States has offered Cuba 3·80 c. per lb. for the entire 1942 crop which Cuba has rejected and is holding for 4·20 c. With regard to the latter report it may be pointed out that for some time past there have been rumours that the United States and the United Kingdom were endeavouring jointly to purchase the entire 1942 Cuban and Santo Dominican exportable surpluses. There is nothing known here to confirm this view, but Mr. W. J. ROOK, the Director of Sugar in the United Kingdom, has been in America for some time as a member of the British Food Mission. It is known that a delegation from Cuba left for the U.S. some weeks ago for joint discussions with United States officials and Mr. ROOK, and latest advices state negotiations are still going on. There appears to be considerable opposition to the scheme in Cuba where many planters contend that the crop would be sold to better advantage if left in the hands of the owners.

Whilst this view may possibly be correct, any permanent easing in the tension in the Far East, thus removing the threat to sugar supplies from the Pacific, would lessen the demand for Cubas. Furthermore, it is not unreasonable to assume that the United States might institute some form of rationing in the event of Cuba holding out for too high a price.

Nevertheless, the combination of the above factors has increased sellers' reserve and some moderate buying in the No. 4 Contract has resulted in prices appreciating 13 to 21 points compared with a month ago, the close on November 22nd being :—

December	2·67	against	2·54	October 23rd
March	2·73½	,,	2·53	,,
May	2·73⅜	,,	2·52⅜	,,
July	2·73⅜	,,	2·53	,,
September	2·74	,,	2·54	,,

In the domestic market U.S. refiners have purchased the balance of the special financed sugars amounting to about 125,000 tons at from 2·26 to 2·30 f.o.b. There are further ready buyers at the maximum price of 3·50 c. c. & f. and parity, whilst Cuban sellers are now disinclined to offer at below 2·75 c. c. & f. or 2·41 c. f.o.b. which are the maximum prices with a duty of 75 c. It is estimated that the cost of production in Cuba for 1942 will be at minimum 1·75 c. f.o.b.

The Maritime Commission in the United States has fixed maximum freight rates for steamers between Cuba and the U.S., the basic rate for North side Cuba to one U.S. North Atlantic port being 34 cents per 100 lbs.

Refined quotations were reduced to 5·25 c. on September 12th and latest reports do not reveal any change therefrom.

C. CZARNIKOW, LTD.

London, E.C.3.
24th November, 1941.

WASTE PAPER FOR MUNITIONS.—A big drive has lately been instituted in the United Kingdom to obtain all the waste paper possible, mainly for use in connexion with munitions requirements, such as cartridge and shell cases, mine assemblies, radio sets, etc. There must be a tremendous amount of old paper stored away both in business premises and private houses—ledgers, record books, old publications, out-of-date books, novels never now read, price lists and catalogues, and the like, and every class of waste paper is wanted, except greasy paper. Those of our readers who live in the United Kingdom will no doubt realize the importance of weeding out at this time all paper material that they can possibly spare and so lightening the task of filling these munitions requirements by means of imports which not only absorb valuable shipping space but are a drain on our finances. To aid the task of collection, a Waste Paper Recovery Association has been formed to co-ordinate the work of the collecting centres and agents, and there should be few places which are not afforded facilities for disposing expeditiously of the waste material found available by the individual searcher.

JAMAICA SUGAR CROPS.—According to figures issued by the Jamaica Sugar Association, the 1940-41 sugar crop of the island came to 156,591 tons, of which all but 45 tons was vacuum pan sugar. The preliminary estimate of the 1941-42 crop is 168,830 tons.

ST. MADELEINE SUGAR CO.—The annual report of this Trinidad sugar company for the year ending June last states that the accounts show a profit for the year of £67,988 (against £14,576 in 1939-40) which, with a balance of £35,917 brought in (against £42,341) and £38,000 placed to reserve for taxation (against £21,000), leaves £65,905 for distribution. A dividend of 4 per cent. (against nil) has been declared, absorbing £27,983, and £37,922 carried forward. The sugar production for the season was 45,293 tons, which compares with 34,044 tons in 1940. This total was well in excess of the estimate and was due chiefly to a large increase in farmers' canes. The expenditure during the year on additions and renewals to plant and machinery was £5478, leaving a balance in renewals reserve of £17,643.

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